

**Exploring the barriers and facilitators experienced by
physiotherapists and patients with musculoskeletal conditions
when using Digital Health Interventions as a self-management
approach in Saudi Arabia: a sequential explanatory mixed
method study**

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List of Abbreviations

DHIs	Digital Health Interventions
JB I	Joanna Briggs Institute
LBP	Low Back Pain
MOH	Ministry of Health
MSK	Musculoskeletal
NTP	National Transformation Program
OA	Osteoarthritis
PT	Physiotherapist
pt.	Patient
SCT	Social Cognitive Theory
TAM	Technology Acceptance Model
UTAUT	Unified Theory of Acceptance and Use of Technology
WHO	World Health Organisation

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Abstract

Background: Musculoskeletal (MSK) conditions constitute a significant public health challenge due to their increasing incidence and potential severe negative impact on patients' quality of life. One recommended treatment is self-management, endorsed in MSK management guidelines, including the National Institute for Health and Care Excellence guideline (2021). Self-management for MSKs can be delivered via digital health interventions (DHIs), which is the term referred to as the delivery of healthcare and the translation of information, knowledge, and communication via digital technologies to help the individual manage their health and well-being. **Purpose:** The present thesis aims to determine and identify barriers and facilitators to recommending and using DHIs by MSK patients and physiotherapists in Saudi Arabia.

Methods: This study used sequential explanatory mixed methods. A cross-sectional design utilised an online questionnaire based on the Unified Theory of Acceptance and Use of Technology (UTAUT) and cultural factors for two populations (MSK patients and physiotherapists). Eighteen users (11 physiotherapists and seven patients with different MSKs) were interviewed within seven physiotherapy departments. This study was conducted during the time period when the use of DHIs was made mandatory by the Ministry of Health (MOH). An audio recording, verbatim transcription, and English translation of the interviews were conducted. Descriptive analysis was used to interpret the quantitative data, and reflexive thematic analysis was used to analyse the qualitative data.

Findings: The questionnaire was completed by 143 respondents (76 physiotherapists and 67 MSK patients). Regarding the patient's characteristics, the most common condition for patients was low back pain (LBP) 46.3% and arthritis 25.4 %, with the majority being chronic conditions (71.6 %). The experience level of utilising DHIs up to two months was common for physiotherapists and less than two months for patients. Almost 90% of patients received no training before using DHIs. Regarding the UTAUT framework, there were mixed views on the compatibility of DHIs with patients' needs. However, both physiotherapists and patients agreed that DHIs improved their therapeutic relationships. Notably, both the physiotherapists and patients also had a substantial level of agreement about their intentions to use and expectations of using DHIs in the future. However, their rate of agreement was lower for using DHI regularly. Four themes were identified under thematic analysis, revealing the areas that support the utilisation of DHIs. Concepts reported within all four themes included aspects, such as perceived effectiveness, patients' willingness to use DHIs, cultural impact, and social influences. The study indicated that physiotherapists who used DHIs before the health delivery organisation deemed this type of delivery mandatory were likely to recommend DHIs to patients with MSKs.

Conclusion: The study reveals that despite initial challenges, such as lack of training and mixed views on compatibility with patient needs, DHIs were viewed positively by both physiotherapists and patients for managing MSK disorders. Although there is a high agreement among physiotherapists and patients about their intentions and expectations to use DHIs in the future, efforts should be made to enhance their regular use in Saudi Arabia.

Implications and recommendations: The study contributes both theoretical and practical implications. Concerning its theoretical contribution, it enriches the literature on DHIs by using the associated constructs of the UTAUT model. Its practical contribution offers valuable information to guide and support the implementation of DHI and training of public hospital physiotherapists and enhance MSK patients' awareness of the benefits of using DHIs. Having

physiotherapists who are familiar with DHIs and can demonstrate ways to apply them is a potentially effective strategy to increase the use of this treatment method Further research is needed to provide insight into the barriers and facilitators that non-users of DHIs may encounter because the current study only included users of DHIs.

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Thesis outline

Chapter 1: Introduction

This chapter provides an overview of MSK conditions, discusses their prevalence, risk factors, and the various management strategies available. It highlights the importance of self-management interventions for patients with these conditions and notes a significant shift towards DHIs. While DHIs offer numerous benefits, further research is still needed. Specifically, understanding how to enhance patient adherence to DHIs is crucial for maximising their potential benefits. Thus, a comprehensive review is needed to explore the usability factors associated with DHI adoption among MSK patients. The current study was conducted within Saudi Arabia's unique context, considering its healthcare system structure, sociocultural influences on health behaviours, and Vision 2030 goals that emphasise digital transformation in healthcare services. Furthermore, given that the study was conducted during the COVID-19 pandemic, there is also a discussion of its impact on several factors including shifts towards digital solutions due to social distancing measures.

Chapter 2: Scoping review

This chapter presents a scoping review of the existing literature. The aim is to provide an overview and synthesis of current knowledge on self-management interventions, DHIs, and patient adherence to these programmes in the context of MSK conditions. This comprehensive exploration informs subsequent phases of the current research conducted within Saudi Arabia's unique healthcare landscape by mapping the existing literature and identifying barriers and facilitators to utilising DHI worldwide. The findings from this review will inform subsequent the phases of the current research.

Chapter 3: Methodology

This section reports the research paradigm, philosophical position, researcher position, and the reasons for choosing mixed methods research. UTAUT was justified as both the conceptual and theoretical framework, explaining the inclusion of cultural factors to best suit the country-based study environments valuing culture.

Chapter 4: Method- Phase I (Quantitative Phase)

The reasons for selecting each method, sample size and survey development are explained, along with the ethical considerations that informed the decision. A scoping review informed this development, as did the findings from the UTAUT method used during the quantitative phase of data collection and the analysis/management/ethical considerations of this project. This quantitative phase method offers an overview of how these findings were utilised to create the survey, data analysis and ethical considerations.

Chapter 5: Results and discussion of Phase I

This chapter comprises two main components: the results and discussion of the survey findings. Demographic data regarding patients and physiotherapists and a general overview of DHI usage in Saudi Arabia are presented. Details regarding DHI training and its implementation are reported with patients' and physiotherapists' preferences and methods. Furthermore, understanding both perceptions of its use is explored using the UTAUT construct. Also presented are both groups' regular usage, behaviour intention and behaviour intention data. A discussion is presented regarding these findings' integration into the broader literature and what should be addressed during Phase II (the qualitative phase).

Chapter 6: Method - Phase II (Qualitative Phase)

This chapter details the second phase of the research including the recruitment of the participants, interview schedules, translation services, reliability and validity issues in conducting semi-structured interviews, and various aspects of conducting them. The steps involved in conducting thematic analysis are described to demonstrate the transparency of the findings. Additional examples include categorising coded items before finally creating and tabulating themes and subthemes from the data.

Chapter 7: Results of Phase II

Phase II's findings sought to expand upon those obtained during the quantitative phase and provide more complete data from multiple perspectives of patients and physiotherapists. Chapter 7 presents the findings from the qualitative phases by detailing four themes that illustrate why DHI should be utilised, barriers and facilitators from patients' and physiotherapists' perspectives, and recommendations for increasing DHI use. Patient and physiotherapist perspectives were distinguished to provide clarity, with the comparison between each theme being integrated into the wider literature. A comparison between the patients' and physiotherapists' views is also provided to better understand how DHIs are being implemented in Saudi Arabia.

Chapter 8: Discussion of the whole Thesis

Key findings for each phase are presented, followed by a triangulation of data between phases by considering the cultural factors investigated and using UTAUT as theoretical framework. In this chapter, the aim is to interpret and synthesise the findings. This can answer the research question and demonstrate implications and recommendations for further study. This chapter provides an overview of the entire thesis, beginning with critical findings from a scoping

review and a comparison of existing literature. Furthermore, the research question is answered and the key findings from both phases are outlined in this chapter. Finally, it provides a brief conclusion of the overall thesis and explains the need for further studies, particularly in Saudi Arabia, to achieve Saudi Vision 2030.

Chapter 1

Introduction

Chapter 1: Introduction

This chapter provides an overview of the thesis and provides information regarding musculoskeletal (MSK) conditions, prevalence rates, risk factors, and impacts on individuals, society, and the healthcare system. The literature review focuses on two specific types of MSK conditions: knee osteoarthritis (OA) and low back pain (LBP). These conditions were chosen because they are the most common not only worldwide but also in Saudi Arabia, where this study was conducted. Understanding their aetiology within the local Saudi population provides a clearer perspective of the conditions. Although the primary focus of this literature review is on knee OA and LBP, a broader perspective that includes various other MSK conditions was adopted when conducting the scoping review (**Chapter 2**). This broader approach sought to capture diverse factors affecting DHI use across various clinical contexts globally, thereby aiming to provide insight into the potential limitations or hindrances healthcare providers and patients with various MSK conditions face.

The following section presents current and traditional MSK management practices provided by healthcare providers. It discusses the challenges and limitations of each management approach offered to MSK patients and provides insight into the self-management approach. It then discusses the involvement of technology as a DHI and its use to assist MSK patients in self-managing their condition. Further discussion focuses on technology's role in DHIs, developed to assist MSK patients in self-managing their condition independently. This chapter will highlight the benefits, barriers and limitations of DHIs while emphasising their educational role for individuals with MSK conditions. As this study was undertaken in Saudi Arabia, a discussion about its context, specifically healthcare systems and sociocultural aspects, is included to enhance the reader's comprehension. Furthermore, as this research took place

during a pandemic, its effects and influences will also be explored. The aim of the thesis and the rationale behind a scoping review will also be detailed at this point before ending this chapter with an overview of the overall thesis outline.

1.1 Musculoskeletal conditions

1.1.1 The prevalence of musculoskeletal conditions

Healthcare professionals use the term MSK to categorise health conditions that affect the neuromuscular-skeletal system. These conditions vary from degenerative joint diseases affecting any joint to severe systematic inflammatory disorders (Woolf et al. 2012). Most MSK conditions are considered long-term, and their common symptoms include pain, limited movement and joint stiffness (World Health Organisation [WHO] 2019).

Musculoskeletal conditions are globally prevalent, impacting millions of people of all age groups (National Health Service [NHS] 2015). It is also considered the leading reason for disability worldwide (WHO 2019). MSK conditions are highly prevalent in the United Kingdom; out of 545 general practitioner (GP) consultations, 115 were related to MSK, resulting in an overall prevalence rate of 21.1% in 2018 (Keavy 2023). Regarding OA, about 10% of adults have been clinically diagnosed with OA in the UK (Swain et al. 2020). Furthermore, LBP has emerged as a significant global health concern, particularly affecting women and individuals between the ages of 40 and 80 (Hoy et al. 2012). The high prevalence of LBP is also confirmed by Wu et al. (2020), who reported that approximately 377.5 million people worldwide had LBP at any time during 1990, and this figure had increased to 577 million by 2017. The prevalence of MSK conditions is higher among women than men and increases with age (Overstreet et al. 2023). According to a review conducted by Bardin et al.

(2017), 90%–95% of LBP cases seen in primary care are classified as non-specific LBP, and the overall prevalence of MSK conditions is high worldwide.

The current study was conducted in Saudi Arabia, so the prevalence of MSK conditions in Saudi Arabia was reviewed. Similar to the worldwide prevalence, MSK conditions are highly prevalent across Saudi Arabia's population and represent one of the critical public health issues (Al-Ajlouni et al. 2019). LBP has been identified as the primary MSK issue within Middle Eastern nations. Al-Ajlouni et al. (2019) conducted a longitudinal analysis that determined LBP to be the most prevalent MSK condition from 1990 through 2019. It should be recognised that most LBP studies have involved workers from varying professions, thus restricting the view of the prevalence of MSK conditions in Saudi Arabia. However, having reviewed the current evidence, it is apparent that several studies have been published. To illustrate this, cross-sectional studies conducted in Arar (Alrowaili 2019), Saudi Arabia, reveal knee OA to be most prevalent among older populations aged 60 years or older. Although these surveys provide valuable data, their conclusions may be limited because recruitment was solely conducted within one city.

Furthermore, evidence shows that OA can occur among younger individuals, which may be related to increasing rates of obesity leading to joint overload which, in turn, contributes to cartilage and bone changes in the knee joint (Chen et al. 2020). In addition, Alnaami et al. (2019) reveal that MSK conditions account for 20% of primary care consultations in Saudi Arabia, representing significant resource utilisation. The systematic review by Aldera et al. (2020) reveal that over a period of 12 months, the prevalence of LBP ranged between 64% and 89% among working-age populations, with females being more at higher risk than males.

Similarly, a narrative review conducted by Milhem et al. (2016) show that the prevalence of MSK conditions was higher among both younger and older female physiotherapists, as well as among older male physiotherapists.

Low back pain has long been recognised as an international public health burden, as demonstrated by numerous systematic reviews and secondary analyses conducted by several researchers and observing the data on the Global Burden of Disease (Chen et al. 2022; Fatoye et al. 2023; Al-Ajlouni et al. 2023). Studies conducted in Saudi Arabia reveal that LBP is also widely prevalent, ranking first and knee pain ranking second among the academic population (Algarni et al. 2020). Several risk factors contribute to high rates of LBP, the occupational impact being one significant influencer. Work-related activities often contribute to LBP in Saudi Arabia due to heavy lifting or repetitive motion requirements associated with certain jobs (Basahel 2015).

Recent studies have identified physiotherapists as exhibiting higher LBP prevalence rates than other professions. This has been verified through cross-sectional studies on teaching staff, office workers and physicians (Aljanakh et al. 2015; Algarni et al. 2020; Alomer et al. 2021; Felemban et al. 2021). In contrast, dental practitioners were found to be more susceptible to neck pain than LBP (Felemban et al. 2021). This is likely to be attributable to prolonged sitting sessions spent bending their necks during procedures that place considerable strain and additional stress on the cervical vertebrae and structures of their cervical vertebral column. However, note that these studies were conducted in a single hospital setting, which means that they provide snapshots at a single point in time without considering potential changes over time, and some researchers maintain that neck pain follows LBP. Therefore, certain occupations may predispose individuals towards developing specific forms of MSK problems

such as LBP or neck pain due to occupational demands but these findings should be interpreted with caution due to the limitations associated with the research design.

According to the WHO, MSK conditions tend to be more prevalent among wealthier nations, although this statement may not be applicable worldwide (WHO 2019). Fransen et al. (2015) conducted research in Asia and discovered that OA was more prevalent among rural dwellers than urban residents. Surprisingly, accurate measurements of MSK condition prevalence can be difficult to achieve in Saudi Arabia because most research focuses on workers across various professions rather than overall population levels, thereby making it difficult to gauge its true prevalence among society. Additionally, lifestyle factors significantly contribute to Saudi Arabia's high prevalence of MSK conditions (Alzahrani et al. 2022), such as sedentary behaviour, lack of physical activity due to the hot weather, and poor diet, which lead to obesity.

Several risk factors contribute to the high prevalence of MSK conditions, including LBP and knee OA. LBP risk factors may include professional working styles such as lifting and transferring patients, repetitive movement and incorrect posture (Milhem et al. 2016), which cause physical stress. Pregnancy or vitamin D deficiency could also increase the prevalence of MSK injuries. According to Awaji (2016), vitamin D deficiency is linked with a higher prevalence of LBP in Saudi Arabia due to limited sunlight exposure and other risk factors among people between the ages of 15 and 52 years (Awaji 2016). Knee OA is considered to be quite prevalent in Saudi Arabia according to a recent study conducted by Althomali et al. (2023). This finding may be partially explained by obesity rates being so high in Saudi Arabia (Alsulami et al. 2023), which increases the risk of knee OA (Althomali et al. 2023). Alsulami et al. (2023) and Al-Hazzaa (2018) confirm that insufficient diet and a lack of physical activity are widespread problems in Saudi Arabia, exacerbating these risks.

Low back pain may affect not only older or specific workers but also younger populations (Alhowimel et al. 2021). Additionally, gender differences are a factor in MSK disorders, with women being more frequently affected than men, a finding that has been confirmed in numerous international and regional studies in Saudi Arabia (Alomar et al. 2021). Certain physical factors specific to women could explain this pattern. For example, these factors include pregnancy, hormonal fluctuations and ligament laxity, all of which can lead to MSK conditions. Consequently, these factors could increase one's risk of various MSK disorders (Wolf et al. 2015). Therefore, considering these factors, it can be concluded that MSK disorders are more prevalent among females than males globally due to these gender-specific reasons.

Age, obesity, sedentary lifestyle and smoking are all contributing factors to increased MSK disorders locally and internationally (Alzahrani et al. 2022; Williams et al. 2018). Williams et al. (2018) conducted a comprehensive meta-analysis involving 13 cohort studies with more than three million participants, revealing an association between MSK conditions and chronic diseases. The study examined data from eight OA studies (n=8) and two LBP investigations, measuring outcomes such as cardiovascular disease incidence (eight studies), cancer occurrence (one study) and diabetes onset (one study). Data showed that those suffering from MSK conditions had an elevated risk for chronic diseases which is 17% higher than those without such conditions and this association was statistically significant with a hazard ratio between 1.13 and 1.22.

Furthermore, it is important to note that variations in the global prevalence of MSK disorders can be attributed to differences in the methodologies applied in epidemiological studies. For instance, cross-sectional studies provide a snapshot of prevalence at one point in time and thus

limit understanding of MSK disorders among populations over time and their associated risk factors (Porteny and Watkins 2013). Most epidemiological research conducted within Saudi Arabia has utilised this cross-sectional design, thereby restricting the comprehension of the true nature and progression of MSK conditions in Saudi Arabia. In contrast, globally conducted longitudinal cohort studies that track participants over extended periods of several months or even years offer deeper insight into the prevalence trends for MSK disorders and their associated risk factors (William et al. 2018). Therefore, when comparing findings from different countries, it is crucial to consider these methodological differences since they can significantly influence interpretations about global patterns for MSK conditions.

Accordingly, researchers should include all societal members, not just workers, to accurately determine the prevalence of MSK conditions in Saudi Arabia. The current scope of data only partially represents this population due to its limited scope and often low quality. Therefore, comprehensive studies are needed for a complete understanding of MSK conditions within the country. However, despite the methodological challenges, it is evident that MSK conditions are a significant public health challenge due to their increasing incidence and negative impact on patients' quality of life (Lewis and O'Sullivan 2019; Rao et al. 2012). Moreover, the influence of MSK conditions stretches beyond the individual patient's quality of life, causing substantial economic, social, and healthcare effects.

1.1.2 The impact of musculoskeletal conditions

Musculoskeletal conditions are considered a universal health priority due to their substantial burden on individuals, communities and healthcare services (Smith et al. 2014; Murray et al. 2013). The pain associated with MSK conditions is often persistent, resulting in adverse effects

on individual well-being and increased disability within a population (Hutting et al. 2019). For example, the pain and functional disabilities of OA patients can lead to coping difficulties, increasing fatigue and depression within this population. A survey by Bener et al. (2013) confirms a high prevalence of depression and anxiety among patients with LBP. Similarly, a systematic review conducted by Sharma et al. (2016) shows a high prevalence of anxiety and depression among patients with OA of the knee. Such psychological factors can also exacerbate pain or fear of movement, reducing physical activity and quality of life (Booth et al. 2017).

The psychological factors related to MSK conditions can extend from the individual to society. To illustrate, LBP has negatively impacted productivity across global industries and other sectors (Martocchio et al. 2000). The limited movement of those with LBP hinders their ability to contribute to activities that improve corporate performance. For example, according to the Office for National Statistics (ONS), approximately 28.4 million workdays were missed due to MSK conditions in the UK (ONS 2020). Furthermore, MSK conditions also significantly affect the finances of and demands on the UK's NHS (Gillman et al. 2018). The NHS is estimated to spend over £4 billion annually on MSK health and social care (Office for Health Improvement and Disparities 2022). Regarding arthritis, the estimated figures from Arthritis Research UK (2017) indicate that in 2010, the UK spent around £16.8 billion on direct medical care and indirect costs such as informal care and lost workdays.

MSK disorders can significantly diminish an individual's quality of life while impacting society in various ways, often leading to reduced healthcare services globally (Chen et al. 2022; Alzahrani et al. 2022; Alshammari et al. 2023). The high incidence rates of MSK conditions impose substantial costs on healthcare services globally and necessitate frequent consultations due to global prevalence levels imposed upon health systems by such issues (El-Tallawy et al.

2021). Individuals suffering from these diseases frequently find that pain inhibits interactions with others and leads to social isolation; this, in turn, may exacerbate health concerns further by contributing to depression or other mental illnesses due to social isolation (Bevilacqua et al. 2021; Brandet et al. 2022). Llamas-Ramos et al. (2022) show that individuals who care for someone living with a chronic disorder may also experience a high prevalence of MSK. At a community level, Lin and Cui (2021) also emphasise that increased demands for accessible facilities, transportation difficulties related to mobility limitations in patients and various service requirements in localities. All these factors have direct and indirect ramifications that impact not only patients but also those around them, especially elderly individuals with MSK disorders (Ghenot et al. 2012). Therefore, MSK conditions have far-reaching repercussions at an individual, familial, social and economic level.

Based on the evidence above, interest in managing MSK conditions has grown, increasing the need for effective treatments to benefit individuals, communities, and health services. Several interventions have been developed to minimise healthcare costs, reduce the severity of pain and disability, and improve the quality of life of MSK patients; interventions provided to MSK patients will be discussed in the next section. Such treatments must be safe, cost-effective and convenient for those with MSK conditions (Nicholl et al. 2017). A literature search will provide insights into the management options available for this population.

1.2 Management of musculoskeletal conditions

Several interventions have been developed to enhance the quality of life and reduce pain among people with MSK conditions. Medications such as paracetamol and anti-inflammatory drugs may temporarily relieve pain while decreasing inflammation. Such interventions have demonstrated marked improvements in acute and chronic pain outcomes among working patients who use them. However, their long-term effectiveness remains unproven, and many

side effects could arise from taking such drugs (Russell 2001; Schnitzer et al. 2004). Osteoarthritis Research Society International (OARSI) guidelines recommend medication for patients at level one of OA, while cardiovascular comorbidity disqualifies them (Bannuru et al. 2019). Due to potential adverse impacts and side effects, such as gastrointestinal damage (Laine et al. 2006), medication cannot always be universally applied across MSK conditions. Due to these adverse side effects from medication use, this option is not typically recommended as a first-line treatment option for such disorders. Given these potential risks, exploring other management strategies becomes necessary.

A wide range of interventions is available for patients with MSK conditions, including electrotherapy, mobilisation, acupuncture and exercise. However, the effectiveness of these treatments varies significantly, according to existing research. For instance, while some studies suggest that electrotherapy can reduce pain levels among MSK patients (Wu et al. 2022), others have shown that the addition of Transcutaneous Electrical Nerve Stimulation (TENS) did not contribute any additional improvements beyond those achieved by education and exercise alone (Palmer et al. 2014) or demonstrate no significant benefit on the level of pain among patients with knee OA (Reichenbach et al. 2022). Similarly, mixed results have been found for interventions such as acupuncture and mobilisation (Westad et al. 2019; Berger et al. 2021), and even if it is effective (Cox et al. 2016; Griswold et al. 2019), it might only be universally accepted or applicable to some patient populations. On the other hand, exercise-based interventions consistently show positive outcomes, such as reducing pain, enhancing functional activity and enhancing the quality of life, across numerous studies conducted over many years (Hayden et al. 2005; Babatunde et al. 2017; Skou et al. 2018).

Musculoskeletal conditions are complex and usually necessitate an approach tailored to individual patient needs, and this approach may include education and exercise. Patient education and exercise are often recommended to treat MSK conditions (Hayden et al. 2005; Fransen et al. 2015; Pieters et al. 2020). A recent systematic review demonstrated the long-term benefits of non-conservative treatment, such as exercises, on patients' pain levels and quality of life (Gianola et al. 2022). However, participating in these interventions may prove challenging due to factors like low motivation or fear of pain (Beinart et al. 2013; Mcleod et al. 2023).

Exercise is widely recognised as a fundamental treatment for patients with MSK conditions. Numerous studies have demonstrated its effectiveness in reducing pain and improving physical activity. For instance, Iwamoto et al. (2011) confirmed the positive impact of strength exercises on patients with mild to moderate OA. Further supporting this view, a systematic review by Fransen et al. (2015), which included 44 RCTs, found that exercise effectively managed these conditions. A recent network meta-analysis conducted by Hayden et al. (2021) suggested that Pilates exercises, functional restoration programmes and the McKenzie method were more valuable than other forms of intervention for chronic LBP sufferers; their analysis incorporated data from 217 RCTs, thereby enhancing its robustness. However, it should be noted that while these methods can effectively reduce pain levels, they may only sometimes be cost-effective due to cost constraints within healthcare services or individual patient circumstances, potentially limiting their general applicability across settings.

The ineffectiveness of previous interventions might be due to the focus on biomedical approaches. The biomedical approach means that the model of health focuses on the patient's biological factors and excludes the influence of psychological and social factors (Williams and

Annandale 1998). In other words, the pathophysiology of the disease was a reason for the illness, and the treatment was mainly directed to considering these factors without involving the psychological and social factors related to the patients. Nevertheless, multiple factors, including individuals' psychosocial and biomechanical characteristics, have often influenced MSK presentation (Hernandez and Peterson 2012). Furthermore, 80% to 90% of LBP cases occur with unknown pathophysiology (Allegri et al. 2016). Consequently, the biomedical intervention might be ineffective, with the patient often being resistant to the current treatment (Lewis and O'Sullivan 2018; Murray et al. 2010). Therefore, other approaches or models of care have been investigated to observe their effectiveness.

There has been a shift from the biomedical approach to the biopsychosocial approach which focuses on the multidimensionality of the MSK system (Keefe et al. 2002). The biopsychosocial model, as developed by George and Engle in 1977, interconnects biological, social, and psychological factors. This approach involves patients in their own treatment and is becoming recognised as an effective intervention for LBP, chronic pain, and arthritis (Covic et al. 2003; Gatchel et al. 2007; Kamper et al. 2015). To effectively address this approach in clinical practice, the patient needs training in self-management methods, as Barlow et al. (2002) have noted that the self-management approach is an alternative model for managing MSK conditions. In this context, the successful management of an MSK condition depends on individual responsibility (Nolte and Osborne 2012) because the patient is spending more time outside the healthcare service (Newman et al. 2004). Hence, the critical component of MSK management is active self-management, as this intervention helps patients learn and manage their condition and is endorsed by most guidelines for MSK management, including the NICE guideline (NICE 2021).

1.3 Self-management of musculoskeletal conditions

Self-management approaches focus on patients' abilities to manage their own conditions rather than on treatments through professional health care (Nicholl et al. 2017). The common definition of self-management is “An individual's ability to manage the symptoms, treatment, physical and psychosocial consequences and lifestyle changes inherent in living with a chronic condition” (Barlow et al. 2002, p. 178). Self-management comprises three tasks, as reported in the Corbin and Strauss framework (Lorig and Holman 2003). The first task comprises the ability of a patient to engage in medical management, such as taking medication and following a healthy diet. Rolling management is the second task which involves new behaviour, lifestyle and maintaining behaviour alteration. To illustrate, LBP patients may change their mode of gardening or join a new favourable sport (Lorig and Holman 2003). The final task required by the patient is to manage emotional factors, such as anger, fear and depression, as these are common psychological factors related to MSK patients. These tasks are the key components of the self-management approach, and there are self-management skills the patient must learn to succeed. Through this approach, the patients become experts in their health and are empowered to follow a healthy lifestyle, communicate with health professionals and avoid the complications of the illness (NHS 2014).

Further, several elements have been developed for the tasks mentioned above to distinguish between self-management and educational intervention; these include goal setting, self-monitoring, problem-solving, building self-efficacy, decision-making, self-tailoring and cooperation between the carers and the patients (Lorig and Holman 2003; Redman 2004). These skills are essential elements in self-management approaches and should be addressed in the intervention to identify self-management efficiency (Lorig and Holman 2003). The three aspects of self-management, namely, behaviour management, emotional management and

clinicians' role in treating MSK patients, also play a critical role in fostering all-around self-management among patients (Lorg and Holman 2003). To achieve recovery, each aspect must work together to promote improved outcomes.

Numerous studies have explored the effectiveness of self-management interventions for MSK conditions. Most studies found these interventions to have no effect or small to moderate effects on patient outcomes, such as reducing disability and pain across various MSK conditions. For instance, Du et al.'s (2011) systematic review noted only a minor impact of self-management among arthritis patients and no effect for those with LBP. Similarly, Oliveira conducted a meta-analysis involving 13 studies that showed that while there was moderate effectiveness in the short-term follow-up period for reducing pain and disability, this effect diminished over longer periods. This aligns with Chodosh et al.'s (2005) findings, stating that self-management had only minimal impact on alleviating pain or improving function among OA patients due to small effect sizes, leading them to conclude that these interventions had no significant clinical benefits.

Oliveira et al. (2012) questioned the effectiveness of self-management interventions, arguing that they may only sometimes yield effective results despite being recommended by guidelines. One potential oversight in earlier studies might be the failure to integrate exercise with self-management, an element often recommended by various guidelines and typically incorporated into successful programs. Some researchers have included exercises in their self-management intervention reviews, yielding partially positive results; however, this area still requires further exploration. To illustrate, Rathnayake et al. (2022) conducted a systematic review and meta-analysis of 9 RCT trials to assess the effectiveness of self-management interventions integrated with exercise on patients with chronic LBP. Researchers showed these interventions had a

moderate effect in the short term that decreased over time for pain and disability; these findings align with those of another systematic review by Walsh et al. (2006) who studied the effects of integrating exercise into self-management among patients with OA. Both studies suggest benefits from combining exercise and self-management strategies across conditions such as OA or CLBP. However, there are important nuances: while Rathnayake et al.'s (2022) study shows that these positive effects decrease over time, Walsh et al.'s (2006) review confirms they may not be clinically significant despite being statistically significant. These findings highlight several guidelines and recommendations to incorporate exercises into self-management programmes for MSK conditions like OA or LBP, even though individual studies show varying results.

Even moderate effects from integrating exercise with self-management suggest that patients derive some benefit from such interventions. However, most of these studies acknowledge that the quality of evidence available could be low to moderate, which could particularly impact the overall findings. Additionally, delivery methods for these interventions were mostly through in-person visits, with few incorporating digital ways, which is a factor worth considering given that support seems crucial for effective long-term self-management, as intervention effects decrease over time (Du et al. 2011; Oliveira et al. 2014; Rathnayake al. 2022). A recent systematic review conducted by Spink et al. (2022) confirms this barrier; poor communication and lack of support from healthcare providers hinder patient engagement in treatment and the ability to manage themselves effectively. NICE guidelines recommend including self-management strategies and exercise as primary treatments for chronic conditions; thus, factors facilitating engagement with these interventions must be carefully considered while keeping the need for high-quality research in mind. Therefore, considering digital tools to deliver such interventions is important.

1.4 Utilisation of technology to facilitate self-management engagement in patients with musculoskeletal conditions.

Digital health intervention (DHI) involves translating information, knowledge and communication via digital technologies (Li et al. 2012). The development of available technology and its application in self-management has resulted in the development of digital self-management interventions for patients. These types of technology, namely mobile phone applications, websites and wearable sensors, are the most popular interventions many healthcare providers use. The promotion of DHI approaches in the self-management of patients with MSK conditions has grown over time. Adopting a DHI in healthcare is a potential solution for reducing the burden of MSK conditions, especially for remote communities and hard-to-reach populations (Palcu et al. 2020). In Wales, the NHS must support people utilising digital technologies (NHS 2019).

Technology in healthcare has many potential benefits, such as cost and time savings, increased patient adherence, and improved self-management for long-term conditions (Imison et al. 2016). Integrating self-management into clinical practice using technology has been the focus of several studies because of its apparent benefits. These include enhanced self-efficacy, improved physical activity and pain reduction through medication uptake management (Murray et al. 2012). In addition, DHI makes it possible to reach out to many patients simultaneously, with none of them being required to visit healthcare facilities in person.

The success of such an intervention depends mainly on its acceptability, usability and feasibility (WHO 2016; Kolasa et al. 2020). The feasibility of monitoring and communicating with a clinical team by using mobile, web-based and sensor-based applications has been shown in several studies (Rabbi et al. 2018). Many researchers have demonstrated that these types of

intervention are feasible, easy to use, enhance knowledge of illness and improve self-efficacy. Although researchers believe in the benefit of utilising DHI to deliver self-management in knee OA and LBP, there have been concerns about using this intervention in clinical practice (Carpenter et al. 2012; Dahlberg et al. 2020). Several factors can limit patients' engagement with technology, and numerous researchers investigating patient adherence have found that high dropout rates and low engagement are common issues in digital health. Factors contributing to these challenges include low literacy skills and lack of motivation. Thus, technology integration into clinical practice has been limited due to several barriers that must be addressed. A systematic review conducted by Meyerowitz-Katz et al. (2020) on 17 studies using DHI for patients with chronic illness noted a 49% participant dropout rate, which is considered high. In addition, Nicholl et al. (2017) reveal that the applicability of the DHI among patients with LBP was limited for participants such as females, threatening the external validity of these studies. Most participants were female, middle-aged, well-educated and white. This highlights where further investigation is required to understand the demographic data for the most recent published studies and address the gaps that still need to be investigated. Nicholl et al. (2017) conducted the review for the period up to 2017 and it should be noted that evidence has advanced rapidly, particularly for the DHI.

Most studies show that DHIs positively impact patients' pain and disability levels, with effects ranging from small to moderate (Valentijn et al. 2022). However, systematic reviews focusing solely on LBP demonstrate no significant changes to either pain levels or disability (Nicholl et al. 2017). This conflicting finding could be attributable to the specific conditions studied, which are known to be complex in terms of contributing factors (Nicholl et al. 2017) or the insufficient quality of those papers reviewed (Valentijn et al. 2022). Understanding DHI use is critical as the world embraces new technological trends in healthcare delivery. Nicholl et al.'s (2017)

study failed to identify any impact of DHI on LBP or disability; this may have been caused by heterogeneity among included studies and implementation without considering exercise, psychosocial approaches or support from healthcare providers, leading to these results. Hewitt et al. (2020) conducted a systematic review. They revealed that an inadequate biopsychosocial approach might explain why some studies found no significant differences in LBP outcomes using DHIs despite their modest effect sizes and limited evidence base supporting clinical practice. DHIs are still considered valuable interventions as they can offer critical MSK outcomes, such as reducing pain (Valentijn et al. 2022), but require further high-quality research to confirm their efficacy.

Bunting et al. (2020) conducted a systematic review to ascertain the efficacy of DHI in engaging MSK patients in exercise. They suggest that DHI has no noticeable impact on patient adherence and does not lead to statistically significant variation between groups regarding patient compliance with exercise regimes. However, only five studies were included in this systematic review, and the data they contain on the efficacy of DHI may be insufficient due to heterogeneity and low-to-moderate quality; consequently, Bunting et al. (2020) failed to identify significant variations that might account for any differences found, possibly as a result of these factors. NICE recommends exercise, education and self-management strategies as part of effective treatment, meaning that it may be difficult to assess the effectiveness of any one element, as MSK disorders often require multi-component treatments to address effectively (NICE 2021).

While Bunting et al. (2021) maintain that DHI is ineffective in enhancing MSK patients' adherence to exercise, Lang et al. (2022) demonstrate that DHI can effectively enhance it. These contradictions can be explained by the nature of these reviews and the evidence

presented by their selected studies. To illustrate, Bunting et al. (2021) included five studies and conducted a meta-analysis for only two, which might be too small a number for detecting significant differences among participants. The remaining studies show the effectiveness of DHI in enhancing patient adherence. However, Bunting et al. (2021) also argue that they cannot provide a strong conclusion based on these studies due to their low quality and limited control group. While this could be accurate, the systematic review conducted by Lang et al. (2022) shows favourable outcomes regarding the use of DHI. Although the included studies exhibit low-to-moderate quality, this does not indicate that DHIs are ineffective. Indeed, DHI is complex, and multiple factors need to be investigated to determine its effectiveness. Therefore, ongoing research is needed to identify the best strategies for enhancing the effectiveness of these interventions. Yang et al. (2020) reveal several issues related to an individual's adherence to DHI that limit long-term engagement with such interventions. Personal, technological, and contextual factors can all impact adherence to DHI, in particular for physical activity. Yang et al. (2020) show valuable information concerning healthy individuals, which cannot be applied to other cases. Therefore, more studies are needed to understand this area.

The current study aims to identify the barriers and facilitators associated with DHI use among MSK patients and physiotherapists in Saudi Arabia. This section provides an overview of Saudi Arabia's environment, healthcare system, sociocultural considerations, Vision 2030 goals, and the effects of the COVID-19 pandemic on these aspects. Additionally, this chapter explains why conducting a scoping review is necessary to achieve this aim.

1.5 Context of Saudi Arabia

Saudi Arabia is located in the Middle East and is widely recognised as both the birthplace and spiritual centre of Islam. The largest nation on the Arabian Peninsula, Saudi Arabia covers an estimated 80% of the total land area and is home to nearly 34 million residents (General Authority for Statistics 2015). It is divided into 13 regions with primary urban centres, including Riyadh as the capital, and other cities such as Makkah and Madinah (Central Intelligence Agency 2018). Saudi Arabia shares borders with seven other nations, including Iraq, Kuwait, Bahrain, Qatar, UAE, Oman, and Jordan. According to estimates by the General Authority for Statistics, the Saudi Arabian population peaked in mid-2021 at approximately 35.8 million individuals, significantly more than in mid-2020 when there were 35.3 million (The World Factbook 2021). According to the World Bank (2020), Saudi Arabia's average annual population growth rate is 1.6%. The Makkah region, with a populace of approximately 8.3 million people, is recognised as the most densely populated city within the kingdom. Riyadh is first in terms of resident distribution, followed by the Makkah region, both of which have high population densities (General Authority for Statistics 2016). The estimated population growth could continue in subsequent years. Saudi Arabia is the location of two of Islam's most holy sites: Makkah and Medina; therefore, the nation is the heart of the Islamic world (Vision '2030' 2016). Survey results show that Makkah's population demographics centre around those aged 15 – 64 (72.9%). School-aged children comprise 23.40% of the country's

population, with retirees over 65 representing just 3.62% (General Authority for Statistics data 2016). Since Saudi Arabia is considered the home of Islam, the religion's influence permeates many aspects of daily life within the population and culture. The following section presents Saudi Arabian society from an overall sociocultural viewpoint.

1.5.1 Sociocultural aspect

Saudi Arabia, an Arabic nation that practices Islam, is widely known as an Islamic country. Islam forms a crucial part of the national identity of Saudi Arabia (Long 2005), with laws, social norms and cultural practices powerfully shaped by it. Saudi Arabia's legal system is founded on Sharia law derived from the Quranic verse and Hadiths of Prophet Muhammad (Vogel 2000). Almallki and Gango (2018) discuss this pervasive influence as one that extends across education, politics, healthcare, personal behaviour and values. Religion influences routines through five daily prayers and fasting during Ramadan as personal behaviours that all Muslims need to follow. Daily life revolves around Islamic beliefs and practices; for instance, prayer times are observed throughout the day, using the Islamic calendar to determine special dates like Ramadan or Hajj. Hajj is among the most significant annual holy performances, and pilgrims comprise its core population. Millions of pilgrims visit Makkah for this religious duty, with two to three million coming annually, which involves high physical demands as they walk to various sites within Makkah on their feet to perform Hajj (Alshehri et al. 2021). Furthermore, the prevalence of MSK was found to be 80.46%, which can be considered high among those who travel to Makkah for the Hajj pilgrimage (Alshehri et al. 2021).

Cultural practices vary significantly throughout Saudi Arabia from the central to the western regions, as Makkah in western Saudi Arabia involves daily pilgrims performing Umrah and annual Hajj pilgrimages that attract over two million attendees (Henderson 2011).

As these pilgrims come from various Eastern and Western cultures, their presence can potentially alter individual cultural perspectives in Saudi Arabia due to constant interaction with various traditions and beliefs. Even though Saudi culture remains deeply rooted in its customs (Al Dossry 2012), recent years have witnessed the erosion of certain societal norms leading to changes in daily life practices and attitudes and beliefs among Saudis (Vision '2030' 2016). Saudi Arabian society adheres to many societal norms and customs that reflect Islam's rules: dress codes that adhere to modesty norms prescribed within Islam, respect for elders, living with extended family, and gender segregation (Azim and Islam 2018; Sidani 2005). Therefore, Islam immensely shapes Saudi Arabia's societal structure and cultural identity.

Gender segregation in Saudi Arabia, an idea which draws heavily from Islamic teachings on protecting females by limiting male–female interactions, has tremendously influenced societal norms (Al Lily 2011). Women and men in Saudi Arabia are separated in the work and education sectors. This separation starts as early as primary school, where girls study separately from boys. Hamdan (2005) states that gender segregation in primary schools has long been seen as necessary to protect vulnerable young girls. Though Islamic beliefs require specific gender roles for protection purposes, this practice does not directly contradict Islam, which emphasises respect for all individuals regardless of gender identity. Al Arabiya News (2019) details this change as being initiated from years one to three of school (release of gender segregation with students beginning in year 1). Recent changes have challenged the longstanding practice of gender segregation. However, as not all schools have implemented these modernising changes, many still adhere to traditional rules regarding gender segregation. Therefore, changing society's attitudes about this matter will take time.

Gender segregation also extends to individuals, as Saudi populations often prefer healthcare providers of the same gender (Alghamdi et al. 2022). DHIs such as mHealth technologies could

enormously impact user engagement; for example, male patients might feel awkward receiving instructions from female physiotherapists via video consultation; this could also apply vice versa. Research indicates that not considering culturally specific factors can reduce users' adoption, effectiveness and satisfaction levels (Alhirz and Sajeev 2015; Alexander et al. 2021). However, there remains to be a greater understanding of this topic within Saudi Arabia among MSK patients and physiotherapists who offer DHI care; thus, this thesis extensively explores this aspect to gain valuable insights for understanding culturally sensitive DHI practices.

Islam has an enormous impact on Saudi culture and emphasises the need to protect women and limit their interactions with men to ensure their safety. This cultural norm pervades daily life but is seen by some as too protective, leading to restrictions on women's rights, such as driving bans and sports team participation bans. In addition, the guardianship system highlighted the trend of requiring female relatives' approval before accessing certain healthcare services like childbirth or surgery for women. Nevertheless, these norms have begun changing with recent societal reforms. Prince Mohammed bin Salman's Vision 2030 plan introduced significant reforms to modernise Saudi society (Vision 2030 2016), including lifting the ban on female drivers, permitting participation of female athletes in sports events, and expanding employment opportunities for them. These progressive steps not only change societal structures but also could transform attitudes and beliefs within Saudi Arabian society.

Furthermore, traditional gender roles in Saudi Arabia often entail men serving as providers while women take responsibility for home management and child-rearing duties (AlMunajjed 1997). While commonly occurring within Islamic teachings, these norms more accurately reflect cultural interpretations than the religious doctrine itself. Islam emphasises equality within a spiritual context, although certain roles and responsibilities may be assigned differently based on factors like physical strength or societal standing (Badawi 1980). As time

passed and social, cultural and environmental factors such as desert living necessitated specific divisions of responsibility between men and women, gender differences further increased into rigid gender roles within society. Modernisation's impact on individual lives and government policies necessitated change; Vision 2030 symbolises this by advocating social reforms that challenge gender norms. For instance, providing women opportunities to work, educate themselves and make healthcare decisions (Vision '2030' 2016), but societal transformation takes time; thus, its effects depend on various factors, including people's reactions and norms toward new opportunities provided through legal reforms.

Similar to the religious aspects of Saudi culture, family life in Saudi Arabia is highly valued, and many aspects revolve around family relationships and obligations. Extended families tend to live together, and elders are valued. Caregivers tend to care for relatives (Moran et al. 2014; Aldhobaib 2017). Hofstede categorised Saudi Arabia as an Arab country that has a collectivist culture influenced by social systems and identities determining decisions (Hofstede 2011). Therefore, social factors and factors related to the family could play an essential role in shaping Saudi Arabian attitudes. Family is highly valued in Saudi Arabian society, rooted in both Islamic teachings and cultural traditions. It is not just limited to immediate family members but also includes extended relatives, resulting in close-knit families often living together or nearby. (Al-Krenawi and Graham 2000). A common trend nowadays is for several generations to live together in one household. It's not uncommon for married adult sons to still reside with their parents and offer each other assistance and support. It is common for siblings and cousins to reside in the same building complex, which reinforces the familial bond and promotes respect for elders in various aspects of life, such as healthcare practices and decisions. Family influence could provide essential social support, yet these ties may present potential obstacles as well. An over-reliance on family decision-making could compromise individual patient confidentiality; similarly, caregiver burden can become an issue without sufficient support

(Alshammari et al. 2023). Thus, when considering DHI, cultural aspects related to family and social support must be carefully considered, as these could have an impact on engagement for patients or physiotherapists.

Additionally, language should also be considered when researching patients' and physiotherapists' experiences in Saudi Arabia. Arabic is spoken across many regions, but Hejazi Arabic tends to predominate in Western cities, while Najdi Arabic prevails in Eastern ones (Prochazka 2013). Rural areas often exhibit distinct linguistic traits that differentiate them from urban centres due to environmental conditions and education levels, with people who live in rural areas tending to be less educated than their counterparts in cities (Almubark et al. 2019). In addition, a systematic review conducted by Almutairi (2015) reveals that language and cultural factors impact the ability of healthcare providers and patients to interact effectively in Saudi Arabia. Although this review only considers healthcare providers, it highlights a critical issue requiring effective explanation and emphasises the need for a deeper understanding of potential cultural barriers among Saudi populations. However, this study does not consider the use of DHI, which could have an additional impact on interactions between healthcare providers and patients.

Regarding DHIs, several studies have been conducted to explore the cultural impact on the engagement of these interventions. The previous studies have been focused on stakeholders, healthcare providers (Ly et al. 2017; Alanzi 2018; Alshahrani et al. 2019; Alodhayani 2021), non-specified conditions among patients (Alajlani and Clarke 2013) or patients with dermatological conditions (Kaliyadan et al. 2013). Alshahrani et al. (2019) assume that cultural factors are the least important factors hindering the acceptance and adoption of e-health in Saudi Arabia. However, the results of this study could not be generalised as the study only provided a stakeholder perspective. By contrast, the results of a cross-sectional survey (Alanzi

2018) revealed that cultural factors, such as privacy and legal considerations, can act as barriers to the adoption of mHealth among diabetes patients in Saudi Arabia. The characteristics of the population in Alanazi's study, a small sample size of healthcare providers (33 participants), limit the generalisability of the study's findings.

Ly et al. (2017) utilised a mixed-methods design to explore the characteristics of physicians working in hospitals in Senegal. They interviewed 30 physicians and discovered that cultural and religious factors impeded their use of telemedicine, despite their intention to utilise this technology. The identified cultural factors were related to patients' religious beliefs about using mobile devices and cameras and family attitudes towards modern medicines that include technology. Senegal is predominantly Islamic, similar to Saudi Arabia, thus confirming the influence Islam can have on individuals' attitudes towards various aspects of daily life. While this study provided valuable data through its mixed-methods approach, it could not be generalised for other populations. The study only included physicians, excluding other end-users such as patients; this may result in an incomplete understanding of cultural factors influencing DHI usage and, more specifically, telemedicine. Similarly, another study which conducted focus groups among healthcare providers in Saudi Arabia identified family roles, language and communication as key cultural factors impacting patient engagement (Alodhayani 2021). However, like Ly et al.'s work, this research also focused solely on healthcare providers without including patients' perspectives, potentially limiting a comprehensive understanding of the influence of culture among patients within Saudi Arabia.

Two studies highlight the influence of cultural factors on patient acceptance of DHIs. Alajlani and Clarke (2013) conducted a case study in Jordan and Syria examining physician–patient interactions. They found that patients resisted using video cameras due to religious beliefs; however, they did not identify specific conditions among these patients, which threatened the

external validity of their findings. In contrast, Kaliyadan et al. (2013) surveyed dermatological patients in Saudi Arabia about their willingness to use camera-based telemedicine methods. Of 166 participants, 23 refused to use this type of intervention for religious or social reasons. While these studies suggest that female Arabic patients may have similar beliefs regarding religion and mobile phone usage for health purposes, generalising these findings is difficult because both studies had small sample sizes or were limited by other factors, such as focusing only on dermatological issues or neglecting to report types of conditions. There needs to be more literature concerning cultural influences on DHI use among MSK patients, specifically in Saudi Arabia. Therefore, this gap necessitates a comprehensive investigation into how cultural, social and environmental factors affect user engagement with DHIs for self-management amongst MSK sufferers within this country.

Understanding these aspects is critical in Saudi Arabia and Middle Eastern society as a whole and can increase the uptake of DHI. The government has implemented several reforms to enhance women's participation in society (Vision '2030' 2016). More places for them to work are being created, and women are being permitted to drive without needing permission from male authorities for travel purposes and transitions like these. This will change the attitudes and behaviour patterns of women in our nation, yet achieving their empowerment goals may take more time and concentrated effort than expected. Considering these aspects is vital when exploring patients and physiotherapists working within society as it transitions from old regulations to modern regulations as this change could have significant ramifications for populations rooted in old regulations while positively impacting populations that adhere to new ones in Saudi Arabia. Additionally, Saudi Arabia is projected to experience population growth that strains its healthcare system as pilgrims visit Makkah, placing additional demands on healthcare delivery systems there. Therefore, implementing interventions which reduce

healthcare burdens and costs via digital transformation initiatives like Vision 2030 plans on doing is imperative (Vision '2030' 2016).

1.5.2 Healthcare system in Saudi Arabia

Saudi Arabia boasts an innovative healthcare system designed to handle the healthcare requirements of individuals, families and communities to enhance the quality of life as public healthcare services are fully funded so all residents may access services free of cost (Mufti 2000). For example, the healthcare system in Saudi Arabia comprises three sectors; 60% of health care is delivered by the Ministry of Health (MOH), and 40% is provided through private practices and other government-supported organisations (Puteh et al. 2020). Hence, the MOH and MOH employees provide oversight to 274 public hospitals located across Saudi Arabia. These healthcare services are in charge of coordination and regulation (Ministry of Health 2021) and are delivered through an extensive network of primary care centres, hospitals, and specialised centres throughout Saudi Arabia. The government has made considerable investments in primary healthcare since 2014, building over 2200 primary healthcare centres that have significantly increased life expectancy while decreasing communicable diseases and infant mortality rates (Ministry of Health 2018). Private healthcare is also flourishing, with 163 private hospitals and 27 private insurance firms currently operating (Ministry of Health 2018). With population growth so rapidly anticipated by Vision 2030, the Ministry of Health has set ambitious plans to meet Vision 2030 requirements (Vision '2030' 2016).

1.5.3 Vision 2030 of Saudi Arabia

Since 1970, Saudi Arabia has implemented a strategic plan to develop all aspects of its nation, including culture, education, health and economy, and this effort has resulted in great transformation. In April 2016, Saudi Arabia presented a strategic plan dubbed "Vision 2030" (2016). This plan primarily aims to diversify Saudi Arabia's economy while lessening its dependence on oil revenues. A *vibrant society* is defined as diverse, inclusive and marked by strong community ties and social cohesion (Vision 2030). This can be accomplished by encouraging cultural development, improving the quality of life for all citizens and encouraging civic participation. The government has set several goals towards this end, such as increasing female workforce participation rates while simultaneously promoting gender equality and improving access to healthcare services while encouraging lifestyle changes. Due to an increase in the population and number of pilgrims, Saudi Arabia's health sector will face greater strain. Prince Mohammed Bin Salman announced Vision 2030 as a long-term blueprint to create an efficient system and a comprehensive sector. Therefore, in line with the announcement of Vision 2030, the National Transformation Program (NTP) was initiated in 2016 as an adequate response (Vision '2030' 2016).

The NPT offers several strategies to achieve Vision 2030 goals, with healthcare being among those sectors covered. One objective is to enhance a healthy lifestyle through campaign-led awareness efforts of common diseases in Saudi Arabia. The plan outlines several goals related to healthcare, such as expanding and improving services by providing accessible yet cost-effective quality of care across both public and private sectors for all citizens. The NPT's third objective is to establish digital health infrastructure by incorporating advanced technologies into healthcare services, including electronic medical records (EMR), telemedicine platforms

and mobile applications which support chronic condition patients (Vision '2030' 2016). Saudi Arabia's healthcare system has already advanced quickly; however, substantial modernisation is required to meet the goals of Vision 2030 (Chowdhury et al. 2021).

As this research began in 2020, prior studies had yet to investigate the current usage of DHI among MSK patients and physiotherapists in Saudi Arabia. Unfortunately, despite ongoing efforts towards Vision 2030 implementation since 2016, limited research exists that investigates DHI usage, and this knowledge gap needs further exploration. COVID-19's appearance supported Vision 2030 by transitioning healthcare services onto digital platforms, thus realising its positive effects in terms of immediate digitalisation. In the following section, an overview of the COVID-19 pandemic and governments' efforts to contain it will be discussed.

1.5.4 Impact of COVID-19 pandemic

Since March 2020, the COVID-19 pandemic has had devastating global repercussions and consequences for healthcare solutions in Saudi Arabia and worldwide. Healthcare systems worldwide have faced numerous difficulties arising from increased service demands due to limited personal protective equipment availability and resources needed for treating patients. Digital health solutions gained rapid popularity due to their ability to facilitate communication between patients and providers while offering continuity of care for non-COVID-related MSK issues (Doraiswamy et al. 2020). The COVID-19 pandemic had global impacts; therefore, it must be considered an integral factor when conducting studies related to DHI in this thesis.

1.5.4.1 Brief overview of COVID-19 situation in Saudi Arabia

COVID-19, caused by the SARS-CoV-2 virus, first emerged in China at the end of 2019 and rapidly spread worldwide (Wang et al. 2020). As soon as the WHO declared a pandemic status in March 2020, governments worldwide, including Saudi Arabia's, began taking steps to limit further spread, implementing regulations and restrictions such as lockdowns and travel restrictions. Thus, the pandemic had far-reaching repercussions for our daily lives, such as disrupted healthcare delivery systems and altered educational modalities, and it forced workplaces to implement remote working arrangements or tighten safety protocols while impacting many other aspects of daily experience. The COVID pandemic spurred rapid digital transformation across various sectors, including education, work and healthcare services. Government rules were implemented, and education paused for two months before transitioning entirely online for two years. The Saudi government implemented several stringent measures in healthcare, such as expanding digital services to reduce physical contact and the spread of the virus. At the same time, routine and non-emergency medical consultations were moved online to avoid physical contact, along with social distancing rules that lasted temporarily but then were gradually released, with the healthcare sector finally lifting its restrictions in 2022.

1.5.4.2 Changes observed during pandemic.

The pandemic showed an unprecedented surge in technology use throughout society. Education, work, and healthcare services all transitioned towards remote methods as an alternative way of dealing with the pandemic. Social distance was required to limit COVID-

19's spread, leading to familiarisation with these technologies beyond previous usage in education, work, government services, and banking services, which all shifted to online delivery methods. Restaurants and shops were shut down, while access to them was prohibited for a significant amount of time. Though these changes harmed business and the economy in Saudi Arabia, technology usage increased rapidly despite such negative aspects of this situation. This situation might not directly relate to my topic, but it had indirect ramifications, including the population's awareness of these online services.

This thesis began on 2nd January 2020, during an important juncture in Saudi Arabia's response to the COVID-19 pandemic. At that point, rapid implementation of new regulations and policy shifts, including an emphasis on DHI, could have made an immediate difference; these measures were put in place to meet immediate public health needs and larger strategic goals such as Vision 2030's focus on digital transformation, potentially hastening individual adoption of new technologies or practices at key moments which influenced responses within this study's context.

1.6 Aim of the thesis

O'Cathain et al. (2019) assert that DHIs involve multiple interacting components that require an iterative and dynamic development process to produce. For a complete understanding of DHIs, it is necessary to appraise existing evidence critically, identify relevant theories, collect primary data using primary collection methods and consider their implementation in real-world settings (O'Cathain et al. 2019). The purpose of the current thesis is not directly to develop a DHI; its primary focus is to explore current usage among physiotherapists and MSK patients and identify factors limiting or promoting engagement with DHIs. By doing so, this research will provide organisations with valuable data on how they may modify existing DHIs to

increase patient and physiotherapist usage rates for DHIs outlined in O'Cathain et al.'s conclusions chapter, and this data could prove vital in improving future implementation strategies (O'Cathain et al. 2019). Following O'Cathain et al.'s (2019) guidance for conducting reviews, this thesis includes an initial scoping review incorporating patient and healthcare provider perspectives while employing existing theories such as UTAUT to understand DHI adoption (Venkatesh et al. 2003).

- **Research question: What are the barriers and facilitators to the use of DHIs by MSK patients and physiotherapists in the Saudi Arabia?**
- The research aims and objectives.
 1. To conduct a scoping review to gain an understanding of the barriers and facilitators to the utilisation of DHIs globally.
 2. To understand the experiences of MSK patients and physiotherapists in Saudi Arabia with DHIs.
 - a. To chart the demographic details of MSK patients and physiotherapists who currently utilise DHIs.
 - b. To identify and understand barriers and facilitators the recommendation and use of DHI by MSK physiotherapists.
 - c. To identify and understand barriers and facilitators of the acceptance and use of DHI by MSK patients.
 3. To formulate recommendations to provide guidance and to improve the utilisation of DHI in the treatment of MSK patients by physiotherapists.

1.7 Rationale of the scoping review.

DHI has seen steady adoption globally, yet there remains a limited understanding of its use within specific contexts such as Saudi Arabia. Due to limited published research specifically regarding the use of DHI as a self-management approach among patients with MSK conditions and physiotherapists' practices in Saudi Arabia or even Arabic countries in general, there were gaps until recently. I conducted an international scoping review involving healthcare providers from different healthcare systems to gain a comprehensive understanding of this phenomenon and provided an inclusive examination that revealed common challenges associated with using DHI interventions. In **Chapter 2**, further details regarding my scoping review, the method used, and the result are presented.

Chapter 2

Scoping Review

Chapter 2: Scoping review

Utilisation of Digital Health Interventions for Self-Management of Musculoskeletal Conditions

2. Introduction

To date, only limited data are available regarding the individual factors that might influence the utilisation of DHI as a self-management approach for MSKs. Several systematic reviews that have been published were focused on the characteristics of the intervention (Brouwer et al. 2011; Hewitt et al. 2020; Nicholl et al. 2017; Najm et al. 2019), but limited data were available related to the patient and individual factors that hinder or promote usage of DHIs among the MSK population. Much of the existing literature predominantly explores patients' experiences with DHIs, leaving a gap in data regarding healthcare providers' experiences (Zanaboni et al. 2018). It is essential to consider both healthcare providers and patients, as they are all end users of DHIs. The insights from both these perspectives can provide a more comprehensive understanding of DHI use, thereby contributing to developing and implementing strategies that cater effectively to all user needs.

Merolli et al. (2022) conducted a cross-sectional study to identify the use of DHIs among patients with MSK conditions and physiotherapists. They found low usage rates among these participants. However, this study was conducted in Australia, which may limit its generalisability to other populations worldwide. Several factors that reduce patient engagement with DHIs have been illustrated by the systematic review conducted by O'Connor et al. (2016). However, understanding of factors concerning individuals with MSK disorders might be limited without specific reference to patients' conditions. Therefore, it is crucial to consider condition-specific influences when examining DHI use among MSK patients. In addition, usability is crucial to ensure DHI utilisation (Yen and Baken 2011), and this can be measured by formative evaluation to indicate the extent of satisfaction. Maramba et al. (2019) conducted

a scoping review to explore the method of testing the usability of the eHealth application. This scoping review was limited as the search period was from 2014 to 2017, and the number of MSKs was limited to adolescent arthritis and fibromyalgia. It cannot be generalised to other types of MSK conditions. Maramba et al. (2019) focused on eHealth intervention without considering self-management as the aim of the DHIs. Thus, more evidence is needed to discover the best method of measuring usability to know the utilisation of DHIs for self-management among MSK patients. Furthermore, given Saudi Arabia's ambition to embrace digitalisation across the healthcare sector (Vision 2030 2016), supported by government bodies like the MOH and policymakers, there is a compulsory need for more data on DHI usage within this context because current data remains scarce. The thesis sought to reflect circumstances specific to Saudi Arabia and consider global perspectives on DHI utilisation. Understanding how DHIs are used worldwide and experiences from different countries can provide invaluable guidance for my current investigation while contributing significantly towards future intervention development efforts. To achieve these objectives, a scoping review at a global level was conducted which is presented in the subsequent chapters.

2.1 Rationale of the scoping review

Conducting a scoping review can help determine the different methods of understanding usability. The scope of a scoping review covers a broader area of research to identify several characteristics or methods related to a specific concept, which, in this case, is the method exploring usability (Munn et al. 2018; Peters et al. 2020). A scoping review was conducted to gain a better understanding of the current research around the use of DHI and the factors that influence participants' views. A systematic review often aims to answer a particular question to determine the effectiveness of the intervention based on specific research types (Peters et al. 2020). However, the purpose of the current review is to explore a range of research aims that

can be fulfilled by conducting a scoping review. It is essential to highlight that the mixed-method systematic review can also involve different types of research; nevertheless, it aims to answer a specific question (Munn et al. 2018) rather than gaining a broad understanding of the field. In contrast, the current scoping review aims to determine all types of evidence related to the method of measuring the usability of self-management DHIs among MSKs. After this evidence is determined, it will be presented by charting the data, and the gaps in the literature can be identified. Thus, a scoping review is considered the most appropriate method to achieve the set objectives.

2.2 Scoping review question

- How do healthcare providers and patients utilise digital health technology to support self-management in MSK populations?

2.2.1 The objectives of the scoping review are:

- To understand the methods used to measure the patient's usage and usability of DHI.
- To identify the barriers to and facilitators of patients with MSK conditions utilising a DHI.
- To identify the barriers and facilitators for healthcare providers of utilising a DHI
- To identify the patient's and healthcare provider's experience of using DHI with MSK patients.
- To identify the gap in the current literature concerning the utilisation of a DHI globally.

2.3 Design

The outline of the Joanna Briggs Institute (JBI) scoping review methodology was followed in the scoping review (Peters et al. 2020). In addition, the protocol for this scoping review was developed and drafted using both the Preferred Reporting Items Extension for Scoping Reviews (PRISMA-ScR) (Tricco et al. 2018) and the JBI guidelines (Peters et al. 2020). The protocol was revised by the researcher and supervisors before conducting the review. Undertaking the protocol was essential to enhance the quality of the review by conducting a practical preplanning step (Lockwood et al. 2019). Therefore, the protocol identified clear objectives and research questions, and it allowed for transparency of the process.

2.4 Search strategy

This review utilised a three-step search strategy, as mentioned in the JBI guidelines for conducting a scoping review (Peters et al. 2020). The first step was an initial investigation in CINAHL and PubMed using keywords related to MSK conditions, DHIs and Self-management. All these initial keywords were presented in **Table 1** as one type of search strategy conducted in MEDLINE database. In this step, analysis of the text was undertaken when the keywords are mentioned in the title, abstract or the authors' primary keywords. The second step involved the identification of all keywords and index terms across several databases, including CINAHL, MEDLINE, and SCOPUS. The reference lists of all identified articles were searched in the third step to identify additional evidence, as advocated for in the JBI guidelines (Peters et al. 2020). Furthermore, grey literature, namely Open Grey and Orca, were searched for relevant organisations and unpublished articles. The researcher asked a qualified librarian to determine any additional keywords and support the further search of the databases, as suggested by Arksey et al. (2005). The librarian advised the researcher to use the shortcut library guide, which was different in each database and enabled advanced searching

techniques. An example of the search strategy that was guided by the Librarian presented in

Table1. Studies were searched if they are published in English and were published at any time.

Table 1: Search strategy and terms used for identifying studies.

Population		Concept 1		Concept 2
Exp Musculoskeletal disease/		Digital health.tw. Exp electronic device/		Self-management.tw.
musculoskeletal.tw.		Exp computer/ Computer.tw.		self-manage.tw.
“Rheumatoid disease*”.tw.		Exp smartphone/ Smartphone.tw.		Exp self-care/
arthritis.tw.		Smartphone.tw.		self-care.tw.
exp arthritis/	And	“Handheld device*”.tw.	And	“Symptoms management”.tw.
exp backache/		“Web-based application*”.tw.		“Self-efficacy”.tw.
“Back pain”.tw.		“Internet-based application*”		Exp pain management/
Exp osteoporosis/		“Digital health”.tw. Ehealth.tw.		
osteoarthritis.tw.		“Wearable technology*”.tw.		
Osteoporosis.tw.		Exp internet/ Exp activity tracker/		
		Exp internet/ Exp activity tracker/ “Fitness tracker*”.tw.		
		“Wearable electronic device*”.tw. App.tw. “Digital health”.tw. “Apple watch*”.tw.		

2.5.1 Inclusion and exclusion criteria

2.5.1.1 Type of participants

Any articles that focused on adults with MSK conditions were included in this review. The conditions that were studied included arthritis, LBP, OA, chronic pain related to MSK, osteoporosis, and rheumatoid arthritis. Whilst specific MSK conditions were highlighted due to their significant impact on the quality of life of adults, it is important to note that the search strategy also included more general terms such as 'Exp Musculoskeletal disease/' and 'musculoskeletal.tw.' (**Table 1**). This approach allowed for a wider exploration of studies related not only to these specified conditions, but also to other relevant musculoskeletal diseases. The aim was not to focus solely on specific conditions but rather to understand the factors that affect the use of DHIs within the broader context of musculoskeletal disorders. This approach allows for a comprehensive exploration of the potential factors that may either hinder or facilitate individuals' use of DHI, insights that can be gained which will provide a deeper understanding of user interactions and guide the next phase of the research.

The review included adult patients (18 years and older), males and females and either educated or non-educated. The main exclusion criteria were the presence of chronic pain related to any other long-term conditions apart from MSKs. In addition, literature was excluded if it included cancer, heart disease, diabetes, Chronic Obstructive Pulmonary Disease (COPD) or rheumatoid arthritis-related to adolescent. Health professionals and healthcarers have also participated in many studies, and previous research has suggested that healthcarers can act as a barrier to or facilitator for patients' utilisation of interventions (O'Connor et al. 2016; Whitelaw et al. 2021). Thus, doctors, nurses and any other qualified health professional caring for adults with MSK conditions were included in this review to generate a multidisciplinary perspective.

2.5.1.2 Types of evidence

All methodologies (i.e., primary research studies, qualitative, quantitative, mixed-method and systematic reviews) were included in this review to gather all the evidence that might give insight into the key factors of this research. Studies were selected if they explored barriers or facilitators for service users, the role of health professionals or the method of measuring usability and uptake usage. Protocols and opinion pieces were excluded since they would not help achieve the objectives and answer the review questions.

2.5.1.3 Intervention characteristics

Digital interventions that support patient education, communication and the relationship between the patient and their healthcare provider were included. This included any digital intervention that is adopted in patient-centred care, including mobile phones, smartphones, apps, websites, web-based Internet applications, mhealth, ehealth wearables and fitness trackers. Studies that used DHIs were only included if they focused on self-management interventions. Furthermore, studies that focused only on the development of a technological intervention without measuring usability were excluded because they did not provide further insight into the barriers and facilitators or the method for measuring the utilisation of the intervention.

2.5.1.4 Context

Settings that provide healthcare services to MSK patients may act as barriers to or facilitators for utilising technology (Lau et al. 2016). In this scoping review, all types of settings where people with MSK use DHIs that were provided by professional healthcare were included. These settings included primary healthcare organisations, outpatient clinics and community services. Restricted inclusion and exclusion criteria might negatively impact the findings of the scoping

review (Arksey et al. 2005). Therefore, no further restrictions for inclusion and exclusion criteria were adopted.

2.6 Concept

Based on the objectives of this review, the researcher primarily focused on the patients' and healthcare professionals' experiences and perceptions. Regarding the intervention, the researcher mainly explored the method of measuring the usability of the DHI among MSK patients. DHIs can be any type of technology that supports the patient with self-management. In addition, the focus on self-management was mainly as a programme that describes self-management as an approach, the patients become experts in their health and are empowered to follow the intervention, communicate with health professionals, and avoid the complications of the illness. The professional healthcarer is a critical component that should provide or support the patient while utilising DHIs (Lorig and Holman 2003).

2.7 Study selection

Typically, two independent reviewers are essential to determine which studies to include and exclude, as demonstrated by Levac et al. (2010). However, due to the nature of the study and it is part of a PhD thesis, the researcher was the only one who screened studies for selection. EndNote was used to screen the title and abstract of eligible studies, and all studies were categorised as files for inclusion or files for exclusion. Justification was provided for studies that were excluded. Once the researcher identified the studies to include, the full text of each study was retrieved. In addition, all reference lists were searched to include relevant studies to the review.

2.8 Data extraction

The template was used to chart precise details of each study, including the study characteristics and results. To enhance the reliability of the scoping review, it is typically advised that two independent reviewers extract the data (Levac et al. 2010). However, this step was not clearly mentioned in the framework for scoping reviews that was developed by Peters et al. (2020). In addition, since this review was part of a PhD thesis, this step was not conducted. Furthermore, Peters et al. (2020) recommended that the researcher extracts the data from the scoping review and presents it as a flow chart that features a logical and descriptive summary of each database result, this step was conducted in this review, which is presented in **Figure 1** in the next chapter. As a preliminary step, data from three studies were initially extracted as part of a pilot process. This helped familiarise the researcher with each study's results (Armstrong et al. 2011; Valaitis et al. 2012), To ensure accuracy in data extraction and interpretation, these initial findings were then discussed with the supervisory team. This step also helped to reach a final decision about the specific variables in each study (Levac et al. 2010).

2.9 Quality assessment

To enhance the quality of the scoping review and increase the uptake of the interpreted results, a quality assessment was needed, and it was used in the current review (Grant and Booth 2009). However, this step was optional to conduct this type of review, as the main aim was to map the relevant literature and identify factors that act as barriers to and facilitators for utilising DHIs. The use of a critical appraisal tool could diminish the number of relevant studies and data, which might be essential to explore the research question. Despite these considerations, the researcher employed the JBI tool for each included study (Peters et al. 2020), and exercised caution when interpreting the results to provide findings relevant to healthcare policy and practice (Brien et al. 2010).

The JBI critical appraisal tool is used when conducting qualitative studies and is regarded as one of the most comprehensive tools to critique qualitative studies (Porritt et al. 2014). Therefore, the JBI tool was utilised to identify the rigour and credibility of the qualitative studies included by considering the type of methodology used in said studies and determining whether it is congruent with the research question. The data analysis process and the interpretation of the results in these studies were also all considered (JBI 2017).

In the scoping review, different types of methodological studies were included, and critical appraisal was conducted for each type of study (i.e., systematic review, qualitative, cross-sectional and quantitative). Thus, other types of JBI tool such as the 'JBI Critical Appraisal Checklist for Randomised Controlled Trials' and the 'JBI Checklist for Mixed Methods Research' was also considered for RCTs and mixed methods studies. Moreover, the quality of the methods was considered so that any bias could be identified. For the pilot studies, a RCT was used; however, not all elements were applicable, such as randomisation, allocation concealment, and blinding of the participants (Mollard et al. 2018). Studies with a high risk of bias were nevertheless included in this review; any type of bias was highlighted in the result and the discussion and interpreted with caution. A critical appraisal was conducted for each study and the results are attached in **Appendix I**.

2.10 Presentation of the results and data analysis.

The results are presented in **Table 2**, that outlines the conceptual categories of each study: the name of author, date of publication, country of origin, aim of the study, type of research, type of intervention, type of method that measured usability, and study population (age, gender and type of illness). Synthesis of data is not considered as critical in a scoping review as in a systematic review (Peters et al. 2020). However, to provide a meaningful result and make

sense of the wealth of extracted data, content analysis was conducted. Content analysis was considered appropriate for reviewing the different types of studies included in this review. This analysis was based on a descriptive approach for coding data and interpretative methods were used to translate quantitative counts into corresponding codes (Morgan 1993). In this review no theoretical framework was followed when developing a code as it was based on inductive analysis. By considering this type of analysis the research can produce a meaningful dataset from the review (Elo et al. 2015).

Content analysis approach involved several steps, the first of which involved the researcher having to read and become familiar with the study content. The second step was to identify the coding units. The rules and terms were identified by connecting similar words and meanings which were then integrated to conceptualise the data. Multiple factors were considered throughout this process such as factors that related to the patient were different from factors related to the professional health care provider (Mosadeghrad 2014). The third step was to develop categories by combining similar coding items and creating definitions for these. The final step involved summarising all the data in the content analysis. The entire process of organising the data was conducted in the NVivo12 software programme. In addition, recoding was conducted to enhance the rigour and reliability of the analysis (Elo et al. 2015). For the quantitative data, a convergent synthesis was adopted which involved transforming the quantitative data into a categorical form. Consequently, similar qualitative and quantitative data were summarised under a single category.

2.11 Results

2.11.1 Results of the search

The result of the study searching and selection after title and abstract screening is shown in the PRISMA chart as described by both Moher et al. (2009) and Peters et al. (2020) (**Figure 1**)

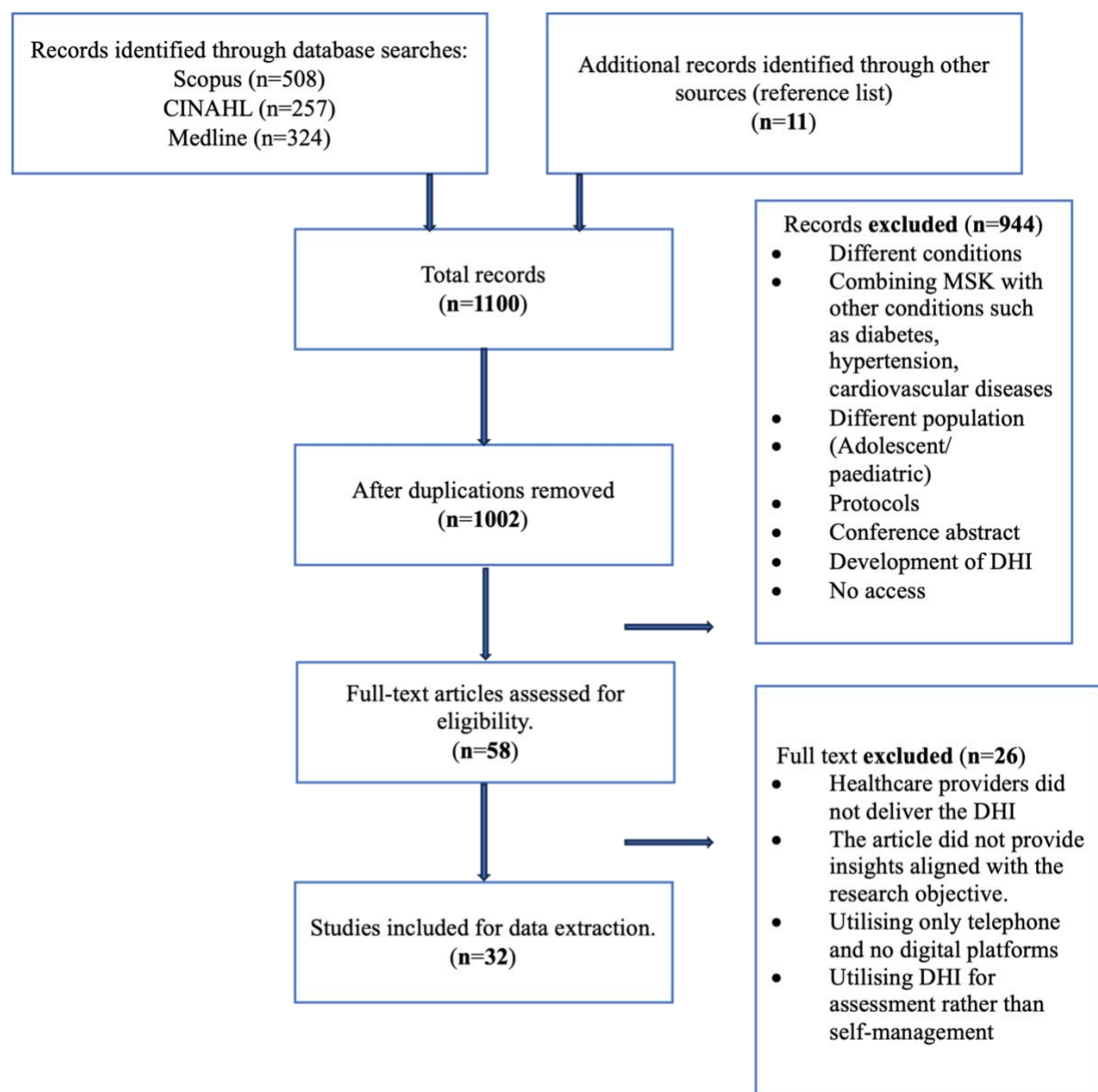


Figure 1: PRISMA flow diagram for study selection process for scoping review (Tricco et al. 2018)

2.11.2 Characteristics of the studies

The characteristics of the included studies are described in Table 3. The studies were conducted in various countries: eight in the USA, six in the UK, five in the Netherlands, four in Australia, two in Sweden, two in Norway, two in Italy, one in Denmark, one in China and one in Canada. Majority of the participants were female; other characteristics, such type of illnesses are also identified. The type of interventions varied from mobile app, website and Fitbit. Furthermore, the rationale for the studies varied from providing support to patients, enhancing their self-management skills, and providing guidelines for care. There were likewise various study types, including pilot or feasibility studies, systematic review, RCT, mixed methods, cohort, quasi experimental and qualitative method. A bar chart (**Figure 3**) demonstrates the number of each paper and the different methodologies that were used. The method most used was qualitative interview, followed by RCT and mixed method. In addition, some researchers conducted a mixed method study as a pilot, where the researcher tested the intervention and then applied qualitative research such as interviews to identify the experiences and usability. Furthermore, one cohort study, and systematic review was also included.

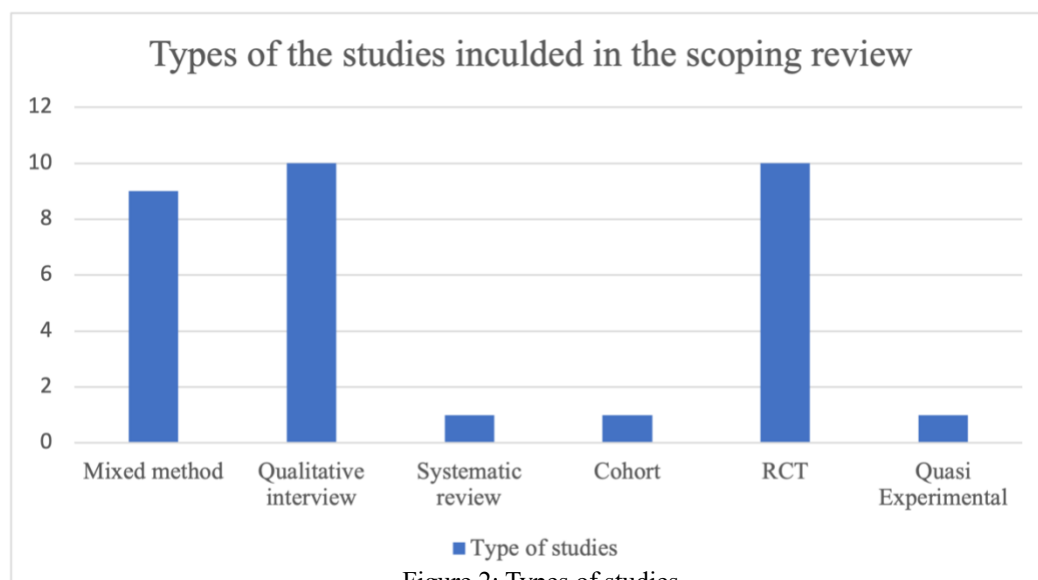


Figure 2: Types of studies

Table 2: Characteristics of the studies included in the scoping review.

Authors	Location	Study aim	Methodology/Method	Age range	Participants	Condition	Type of DHI, medium	Usability methods
Algeo et al. (2017)	UK	To explore attitudes toward, barriers to and facilitators of using e-health for OA patients	Semi-structured interview	42–74 years	10 patients 70%Female, 30% Male.	OA	MyjointPain website self-management	Semi-structured interview
Allen et al. (2018)	USA	To compare the effectiveness of internet-based exercise training (IBET) with physical therapy in various waitlist groups among patients with knee OA.	RCT	54.2-76.2 years	350 patients 69% Female, 31% Male	OA	Web-based application	The number of participants logged onto the website.
Amorim et al. (2019)	Australia	To identify the feasibility of integration of web-based self-management, Fitbit, 12 face-to-face physiotherapy and telephone support among patients with LBP	Pilot: RCT	47.6-71.4 years	68 patients 44% Female, 56%Male	LBP	OAself-management and telephone support 12-month	The number of completeness of primary outcome (survey via web). The number of health coaching sessions. Time wearing accelerometer.
Bennel et al. (2017)	Australia	To identify the efficacy of internet-delivered pain coping skills training and exercises by physiotherapists among patients with chronic knee pain.	RCT	54.3-67.3 years.	148 patients 58% Female, 42%Male	Chronic knee condition	Web-application (PainCOASH)	Self-report

Table 2: Characteristics of the studies included in the scoping review.

Authors	Location	Study aim	Methodology/Method	Age range	Participants	Condition	Type of DHI, medium	Usability methods
Bhattarai et al. (2020)	Australia	To explore the attitudes and experiences of older people with arthritis using a pain self-management application	Qualitative semi-structured interviews	68.2–78.2 years	16 participants 89% Female, 11% Male.	Arthritis	Mobile application	Interview
Bhattarai et al. (2020)	Australia	To explore the attitudes and perspectives of healthcare professionals regarding integrating and using pain self-management applications with elderly people with arthritis	Qualitative semi-structured interviews	36–56 years	17 participants (four primary care and allied health clinicians – four physiotherapists, four general practitioners, two clinical psychologists, one osteopath, one specialist pain physician and one emergency department physician). Experiences in clinical practice: 10–30 years	Arthritis	Mobile application	Interview
Button et al. (2018)	UK	To define the content, setting and context and develop a training for implementing TRAK, in outpatient service and to identify barriers and facilitators based on the patient and physiotherapy experiences.	A mixed method study: Phase 1 – qualitative interview, Phase 2 – feasibility study of using TRAK	48.76–36.07 years	15 physiotherapists and 16 patients with knee conditions 62% Female, 48% Male	Acute, chronic, postoperative knee condition	Web-based self-management (TRAK)	- Number of participants follow-up - Number of physiotherapy sessions - Number of updating plans

Table 2: Characteristics of the studies included in the scoping review.

Authors	Location	Study aim	Methodology/Method	Age range	Participants	Condition	Type of DHI, medium	Usability methods
Cronstrom et al. (2019)	Sweden	To explore the experience of patients with knee OA using a digital self-management programme	Qualitative study, semi-structured interviewee.	45–80 years	19 patients 52% Female, 48% Male	knee OA	Web-based self-management (Joint Academy)	Interview
Dahlberg et al. (2016)	Sweden	To identify the effectiveness of the web-based OA self-managing programme.	Pilot study; cohort prospective longitudinal study	43–71 years	53 patients 73.6% Female, 26% Male	OA	Web-based self-management	The data for usage was reported by the number of participants utilising the intervention at different weeks (6-12-18-24-30 weeks).
De Vries et al. (2017)	Netherlands	To understand the factors influencing patient adherence to a web-based intervention integrated within physiotherapy for patients with knee or hip OA	A convergent mixed method	55.3–71.9 years Interview: 51-79 years	90 patients 67.8% Female, 32.2% Male Interview: 10 patients 70% Female	Duration of the OA: 17.8% less than one year, 41% one–five years, 41.1% more than five years. Comorbidity: non (48%), one (18%), more than one (24%), interview: non (60%)	Web-application	- Analytic website usage - Semi-structure interview
Eysenbah et al. (2016)	Netherlands	To identify the feasibility of online intervention integrated with physiotherapy sessions among patients with knee or hip OA	Pilot study: mixed method	47.35–76.41 years (patients with OA)	Nine physiotherapists and eight patients with OA. 75% Female, 25% Male	OA	Web-application e-Exercise	SUS

Table 2: Characteristics of the studies included in the scoping review.

Authors	Location	Study aim	Methodology/Method	Age range	Participants	Condition	Type of DHI, medium	Usability methods
Geraghty et al. (2018)	UK	To test the feasibility of the internet and usage of DHI among patients with LBP	RCT feasibility studies	Intervention group plus usual care 40.8–68.2 years (92% white ethnicity)/Intervention group plus telephone support 48.9–69.7 years	87 patients with LBP 58% Female, 42% Male.	LBP	Web-based self-management (SupportBack)	Questionnaire via website.
Geraghty et al. (2019)	UK	To test the feasibility of the internet and usage of DHI among patients with LBP	Semi-structured interview	40–76 years	87 patients 51 Female, 36 Males	LBP	Web-based self-management (SupportBack)	Think aloud interview
Hewitt et al. (2020)	UK	To explore the characteristics related to the population who benefit from DHIs.	Systematic review	35–69 years	22 RCT/ Female dominant.	MSK	DHIs	NA
Hou et al. (2019)	China	To identify the efficacy barrier for low and high adherence rate.	Prospective RCT	41.61–60.65 years	168 patients 57%Female	Postoperative Lumbar Spinal surgery	Mobile application	App analysis and adherence

Table 2: Characteristics of the studies included in the scoping review.

Authors	Location	Study aim	Methodology/Method	Age range	Participants	Condition	Type of DHI, medium	Usability methods
Ravn Jakobsen et al. (2018)	Denmark	To explore the experiences of women with osteoporosis using mhealth to prepare for decision-making regarding treatment with clinical practice and how the women self-manage by using mHealth	Qualitative open-ended questions and semi-structured interviews phenomenological method	50–65 years	20 patients 100%Female	Osteoporosis	Mobile application (My osteoporosis)	Self-reported questionnaire during the interview
Kloek et al. (2018)	Netherlands	To identify the effectiveness of e-Exercise compared to physical therapy sessions among people with knee or hip OA. (12 months)	Cluster RCT	55.3–72.3 years.	208 patients 67.9% Female, 32.1% Male.	OA	Web-application	SUS (average) at 3months
Kloek et al. (2020)	Netherlands	To explore the experiences of physiotherapists with using a blended web-based approach with OA patients.	An explanatory sequential mixed method	29–55 years	123 physiotherapists 53% Male.	42% master physiotherapy-specialisation	Web-application	Interview
Kristjansdottir et al (2011)	Norway	To assess the usability of mobile applications that supports self-management among chronic widespread pain	Usability study	23–48 years	Sex: Female.	Chronic widespread pain	Mobile-web application	The number of completed diaries per participant and interview

Table 2: Characteristics of the studies included in the scoping review.

Authors	Location	Study aim	Methodology/Method	Age range	Participants	Condition	Type of DHI, medium	Usability methods
Mollard et al. (2018)	USA	To determine barriers to utilising the app among adults with hand RA.	Pilot study: mixed method design	No information	12 participants with RA	Hand RA	Mobile application (Live with arthritis)	Interview
Najm et al. (2020)	UK	To explore the experiences, views and needs of people with MSK diseases using a mobile app that offered self-management.	Mixed-method study/ Focus group and national organisation survey followed the themes that emerged from the focus group	18–65 years	Six patients with rheumatoid arthritis in a focus group 424 patients with different MSK (RA 38%, fibromyalgia 20.4%, OA 16% and others) 82%Female, 18%Male	RA and MSK	mhealth	Focus group
Nordstoga et al. (2020)	Norway	To measure the usability and acceptability of the mobile app, which includes three components of self-management among patients with LBP.	Sequential exploratory mixed method study	23–56 years	26 patients 57%Male, 43%Female.	LBP	Mobile application (SelfBACK)	SUS, application analysis and interview
Parker et al. (2013)	USA	To identify barriers to and facilitators of adopting mhealth pain management among an older population.	Qualitative design (focus group)	66.9–85.5 years	41 participants Mean age: 76 years 78% female	LBP 41% Degenerative joint disease 51%	General application for pain management	NA

Table 2: Characteristics of the studies included in the scoping review.

Authors	Location	Study aim	Methodology/Method	Age range	Participants	Condition	Type of DHI, medium	Usability methods
					41% LBP and 51% degenerative joint diseases			
Leese et al. (2019)	Canada	To compare and contrast both arthritis and rehabilitation professional perspectives regarding the use of a physical activity tracker for arthritis self-management.	Qualitative study (focus group)	23–78 years professionals participated, with 5 to 38 years experience	40 patients with arthritis 77% Female, 23% Male 25 professionals participated	40%OA 37%RA 17% both.	Fitbit	Interview
Lorig et al. 2008	USA	To identify the effectiveness of the internet-based Arthritis self-management program for a period of 6 months and 12 months.	RCT	42.2–62.2 years	441 patients 55% Female, 45% Male	OA and Fibromyalgia	Web-based self-management (Internet-based Arthritis Self-Management Programme (I-ASMP))	The number of participants posted on the website and workshop.
Sparks et al. (2016)	USA	To assess patient perspective after using Fibroguide to enhance self-management in clinical practice.	Pilot study (questionnaire and open-ended question survey)	37.65–64.53 years	35 patients 91.4%Female, 8.6% Male	Fibromyalgia	Fibroguide (DVD) computer medium	Questionnaire
Selter et al. (2018)	USA	To identify patient-perceived utility by using the application for self-management for patients with LBP.	Pilot experimental study	30–62 years	93 patients 63%Female, 37%Male	LBP	mhealth application	Questionnaire
Schulz et al. (2007)	Italy	To identify the issues related to the Oneself after development among LBP patients	Pilot experimental study	41–49 years	20 patients 25% Female	LBP	Web-based self-management (Oneself)	Retention rate, average of website visits and questionnaire

Table 2: Characteristics of the studies included in the scoping review.

Authors	Location	Study aim	Methodology/Method	Age range	Participants	Condition	Type of DHI, medium	Usability methods
Trudeau et al. (2015)	USA	To determine the effectiveness of online self-management intervention among adults with arthritic pain.	RCT	38.3–62.3 years	113 patients with OA 55%Female, 45% Male.	OA	Web-based self-management (Pain Action)	- Analytic method: number of viewed pages. (Advice 20 minutes, two times per week) 4 weeks duration of the intervention
Zaslavsky et al. (2019)	USA	To identify the feasibility of mhealth for providing self-management intervention to improve sleep among patients with OA.	Pilot study	67–75 years	24 patients 70% Female, 30% Male	OA	mhealth/self-management Fitbit	- Step count. - Application analysis.
Caiata Zufferey and Schulz (2009)	Italy	The role of DHI, which is Oneself in the attitudes and behaviour of patients with CBP.	Qualitative study (grounded theory/ in-depth interview)	28–72 years	18 patients 50% Female, 50% Male	CBP	Web-based self-management (Oneself)	Interview
Zuidema et al. (2019b)	Netherlands	To explore the non-usage experiences.	Qualitative interview	Nonuser 57 low user (1–5 times) 64 High user (> 6 times) 50 High user 66.5	Nonuser 50% Female low user (1–5 times) 100% Female High user (>6times)90% Female High user more (< 6 times)	RA	Web-based self-management	Interview

NA: Not-available, **DHI**: Digital Health Interventions, **OA**: Osteoarthritis, **LBP**: Low Back Pain, **RCT**: Randomised Control Trail, **RA**: Rheumatoid Arthritis, **SUS**: System Usability Scale, **MSK**:

Musculoskeletal, **CBP**: Chronic Back Pain. **UK**: United Kingdom, **USA**: United States of America, **TRAK**: Taxonomy for the Rehabilitation of the knee condition.

2.12 Methods of measuring and exploring the use of Digital Health Interventions

One of the objectives of this review was to identify the methods employed by the studies to measure the use of DHIs, and Table 3 illustrates the different types of processes for each study. There were differences in how the methods were reported and the methods themselves varied. These included semi-structured interviews, questionnaires, web analytics, and focus groups.

2.12.1 Semi-structured interviews

This is the most common method that researchers utilised to obtain information about using DHIs (Button et al. 2018; Cronstrom et al. 2017; Bhattarai et al. 2020; Eysenbah et al. 2016; Kristjansdottir et al. 2011; Klock et al. 2016; De Vries et al. 2017; Alego et al. 2018; Ran Jakobsen et al. 2018; Cronstrom et al. 2019; Bhattarai et al. 2020a; Geraghty et al. 2019; Nordstoga et al. 2020; Mollard et al. 2018; Zuidema et al. 2019; Zufferey 2009; Hou et al. 2019; Amoriom et al. 2019). The telephone interview was the most popular format for the previous authors to explore the use of DHIs.

2.12.2 Questionnaires

The second most common method of measuring usability was a questionnaire, and six out of the 32 studies used a questionnaire after the intervention period had ended (Schulz et al. 2005; Bossen et al. 2016; Sparks et al. 2016; Klock et al. 2018; Selter et al. 2018; Hou et al. 2019). The specific type of method varied between the studies; it was either a paper questionnaire or a web-based questionnaire. For example, Selter et al. (2018) used a web-based questionnaire, and among 93 patients with CLBP, only 38% of patients completed the questionnaire. An online survey may not work well for online DHIs. If participants do not utilise the DHI due to a lack of appropriate technology, they would not be able to access the

survey, resulting in selection bias. However, Hou et al. (2019) utilised a paper questionnaire. While using a paper method might encourage subjects to fill out the questionnaire, the attrition rate was high in this study, and the author revealed that the paper questionnaire could be the reason. Therefore, a questionnaire method may be suitable for all participants if offered both on paper and online. Despite the simplicity of this method, there were only three studies that utilised a valid questionnaire which was called the System Usability Scale (SUS) (Eysenbah et al. 2016; Kloek et al. 2018; Nordsdigan et al. 2020).

2.12.3 Website/online analytics

Another method used was website analytics. The developer or the leader of the intervention would use a service to monitor the number of participants who logged in (Lorig et al. 2008; Allen et al. 2018; Zuidema et al. 2019; Bennell et al. 2017); the time that each patient spent on the program (Dahlberg et al. 2016; Trudeau et al. 2015); the number of participants who completed an online self-report questionnaire (Amorion et al. 2019; Trudeau et al. 2015); the frequency of interaction with the self-reports, number of videos watched, or frequency of messages exchanged with health providers (Selter et al. 2019); the number of participants starting and completing the session (Geraghty et al. 2018); the number of participants who completed at least 8 out of 12 modules and adhered to the intervention (Kloek et al. 2018); the number of eligible patients, enrolment rates, retention rates (Zaslavsky et al. 2019); and several evaluations were conducted online over a period of weeks (De Vries et al. 2017). Despite the efficacy of this method, threats to the patient might arise because patients have raised concerns about the privacy and safety of this type of analysis. Therefore, from an ethical perspective, this type of analysis must be acknowledged and described in a clear way for the patient.

2.12.4 Focus group

Only three studies utilised a focus group (Leese et al. 2019; Parker et al. 2016; Najm et al. 2019). All these studies included patients and healthcare professionals who were either experienced or inexperienced at utilising DHIs.

2.13 Healthcare providers' and musculoskeletal patients' experiences using DHI

The overall experiences of both patients and professional healthcare providers were positive and demonstrated that DHIs are easy to use and carry therapeutic benefits for patients (Button et al. 2018). However, some studies revealed negative experiences related to the content of the technology; frustration and other factors can act as barriers to using DHIs. The theme that emerges in the following section is related to the negative and positive findings from these experiences. The negative effects act as a barrier to the usage of DHIs, while the positive effects were related to the factors that, overall, benefitted both patients and professional healthcare providers. Therefore, the third objective of this scoping review emerged with the factors that facilitate and hinder the utilisation of DHIs.

2.14 Themes that emerged from the studies

The themes that emerged from the analysis can be categorised according to the study's objectives. To illustrate, barriers to utilising DHI related to the patient and providers and facilitators to utilising DHI related to both patients and providers. As for individual factors, O'Conner et al. (2016) showed that end-user factors may impact the utilisation of DHI both for the patient and the healthcare provider. Therefore, these categories were adopted while developing the data analysis process to achieve the desired objective. Two main themes were

identified in the current scoping review, the first theme pertains to the factors that either hinder or facilitate MSK patients to use DHIs. The second theme is related to the healthcare providers' perspectives on the factors that impede or enhance their using such interventions.

2.15 Factors facilitating and hindering the use of DHIs.

2.15.1 Patients' facilitators and barriers

Table 3 represent the themes that were identified and the frequency of each theme for patients.

The frequency was measured by the total frequency of existence of facilitators or barriers.

Table 4: Percentage of patients' barriers and facilitators

Facilitators	Percentage%	Barriers	Percentage%
Communication influence of the patient-provider	22.5%	Lack of patient-provider communication	25%
Motivation	22.5%	Functionalities of the intervention	25%
Perceived usefulness	17.5%	Lack of motivation	10%
Functionalities of the intervention	15%	Limited access to the internet	10%
Physical characteristics	10%	Concern about privacy and security	7.5%
Training and familiarity	7.5%	Negative outcome	7.5%
Technical skill	2.5%	Lack of technical skills	7.5%
Previous knowledge	2.5%	Concern about cost	5%
		Lack of training	2.5%

2.15.1.1 Physical characteristics

In considering facilitators, ample evidence suggests that the duration of the illness may act as a facilitator. The duration of the illness varies in the literature depending on the type of MSK condition. To illustrate, a qualitative interview conducted by Caiata Zufferey et al. (2009) found that patients who had suffered from CLBP for many years behaved differently than those experiencing a recent episode. It is possible that patients with a longer period of CLBP may be more engaged with DHIs, potentially due to their increased familiarity with these types of interventions. De Vries et al. (2019) confirmed this finding with a different condition, knee OA, in a mixed-methods study that found that high adherence was associated with patients with one to five years' duration of OA. Thus, a patient with a recent diagnosis of the MSKs may act differently than one with a chronic condition.

By contrast, Geraghty et al. (2019) indicate that the severity of the disease and the presence of low and middle levels of pain discouraged LBP patients from using the SupportBack web-based application. However, the authors failed to include the duration of the LBP condition, instead describing the duration of the pain. As such the exclusion criteria were not precise, which may call into question the internal validity of the study (Portney and Watkins 2013). Therefore, describing the level of pain may not be related to the LBP, and other confounding factors could be the cause of the patients' reluctance to use Support Back.

Contrary to the above, Dahlberg et al. (2016) found that the level of pain did not affect intervention use among patients with knee or hip OA. However, their pilot cohort study could not provide definitive answers about the causal relationship between the variables of pain and disease stage because of the high attrition rate; only 6 out of 53 patients completed the intervention period (30 weeks). Caution must be taken when attempting to gather data in this

causal relationship as other factors may limit patients' DHI use, such as level of education and duration of illness and Dahlberg et al. (2016) failed to include those factors in their work.

Despite the inconsistency of their findings, several studies confirm that patients' characteristics may act as barriers to using DHIs. The studies of Leese et al. (2017), Mollard et al. (2018), Bhattarai et al. (2020), Allen et al. (2018), Nordstoga et al. (2020) and Lorig et al. (2008) all show that diverse factors, such as comorbidity, fatigue and higher levels of distress and pain, limited patient engagement with DHIs. Nevertheless, personal characteristics may have a considerable influence on patients' willingness to use DHIs and must be carefully considered when implementing and employing DHIs.

2.15.1.2 Patient-provider communication

Communication has been reported as a critical factor that may either enhance or hinder the use of DHIs. The enhancement of their use was related to worthy communication as patients feel reassured and can understand their conditions and share in decision-making (Sparks et al. 2016; de Vries et al. 2017; Jakobsen et al. 2018; Cronstrom et al. 2019; Geraghty et al. 2019; Najm et al. 2019). For example, 18 patients with a recent diagnosis of osteoporosis found it easy to understand the result of a bone scan when their physician communicated with them (Jakobsen et al. 2018). Moreover, both Leese et al. (2017) and Najm et al. (2019) confirmed this by conducting focus groups, finding from the patients' previous experiences that mHealth improved communication with healthcare professionals. Furthermore, Button et al. (2018) show that communication with a physiotherapist and the provision of a personalised exercise plan facilitated DHI use among patients with knee conditions. Finally, a systematic review by Hewitt et al. (2020) found that variation in support may explain enhanced engagement, with more significant support related to a positive outcome.

In contrast, poor communication with healthcare providers may act as a barrier, as evidence shows that inadequate communication is likely to reduce the level of engagement and result in a high attrition rate. For example, Hou et al. (2019) surveyed 116 patients after lumbar spinal surgery and found that the most common barrier to the use of mobile phone self-management was a lack of communication between the patient and physician. In addition, Bhattarai et al. (2020), Parker et al. (2013), and Zuidemia et al. (2019) revealed that patients need support and integration from a professional healthcare provider. Although Bhattarai et al. (2020) found that a high adherence rate was associated with the group treated with additional physiotherapy telephone support, patients were not satisfied with this kind of intervention. Zufferey et al. (2009) highlighted the importance of communication with professional healthcare. However, they also noted that some experienced a confusion due to a lack of understanding about their health problems. This suggests that there may be room for improvement in how information is conveyed by healthcare professionals, and it implies the need for additional forms of support from these providers to help patients better understand and manage their conditions. Thus, incorporating other forms of support from a professional healthcare provider may help overcome these issues.

Several studies highlighted that not all patients were satisfied with their communication with a professional healthcare provider because of late responses and even a lack of response (de Vries et al. 2017; Cronstrom et al. 2019; Nordstoga et al. 2020). Schulz et al. (2007) found that LBP patients were unsatisfied with their interactions with physicians. Therefore, inadequate communication acts as a barrier, while appropriate communication facilitates use. Furthermore, Trudeau et al. (2015) found a significant difference in time effect in patients who experienced high engagement and communication with physicians as compared to those with low engagement. However, the researchers did not determine cause and effect, which needs to be explored (i.e., does communication with the physician lead to high engagement or vice versa?).

2.15.1.3 Training and familiarity with the intervention

Training may be an essential element that should be given to patients before implementing an intervention. Three studies report that one facilitator of engagement with DHIs is training in digital technology (Parker et al. 2013; Button et al. 2018; Bhattarai et al. 2020), which may facilitate adherence by familiarising patients with the digital intervention.

Lack of familiarity has been found to be a barrier to the use of DHIs (Najm et al. 2019). Parker et al. (2013) report that 31.7% of their participants were concerned about this issue. Some studies have trained participants before allowing them to use their DHIs, but the extent of training varied between these studies. For example, some studies provided a brief orientation or written instructions on the use of the application in the form of a letter (Alego et al. 2017; Bennell et al. 2017; Dahlberg et al. 2016; Ravn Jakobsen et al. 2018; Smarr et al. 2011; Sparks et al. 2015; Mollard et al. 2018). One study provided training and support via a healthcare provider for 14 weeks (Zaslavsky et al. 2019), and others created accounts for their patients via professional healthcare workers (Allen et al. 2018; Kloek et al. 2013).

Physiotherapists have indicated the need for dedicated time during face-to-face encounters with patients to familiarise themselves with using DHI, as highlighted by Button et al. (2018). Finally, some studies sent participants a link to the website without any training at all (Trudeau et al. 2015; Eysenbah et al. 2016; Geraghty et al. 2018; Selter et al. 2018). Thus, a lack of familiarity with the DHIs may exist due to a lack of training, so more studies are needed to investigate this possible correlation.

2.15.1.4 Technical skills

DHIs require that patients possess the skill to use this type of intervention, and the inclusion criteria of all the previous studies include this element, but some people declined to participate or to continue participating due to their lack of skill in using technology (Ravn Jakobsen et al. 2018; de Vries et al. 2017; Klock et al. 2020). Button et al. (2018) revealed that patients require basic computer skills to use technology and the internet. Concurrently, to enhance the intervention's implementation, the study's physiotherapist needed to be an expert on the app and be familiar with all the relevant technology during consultations with patients. A lack of technological skills may impair self-confidence, ultimately causing study attrition or exclusion.

2.15.1.5 Motivation

Motivation was one of the more frequently reported facilitating factors in the studies reviewed here (Caiata Zufferey et al. 2009; Alego et al. 2019; Bhattarai et al. 2019; Cronstrom et al. 2018; Geraghty et al. 2019; Leese et al. 2019; Mollard et al. 2019; Nordstoga et al. 2020). Patients had to be encouraged to use DHIs, and, in several studies, notifications and weekly email reminders seemed to encourage patients to track their progress (Alego et al. 2019; Bhattarai et al. 2019; Eysenbah et al. 2016; Cronstrom et al. 2018; Geraghty et al. 2019; Mollard et al. 2019; Caiata Zufferey et al. 2009; Selter et al. 2018). TRAK, which provides a personalised action plan, exercise video and goal setting, associated with the element of motivation (Button et al. 2018). Similarly, Kristjansdottir et al. (2011) show that the feedback note is a motivating feature for patients with chronic widespread pain. This feature is attractive to patients because it addresses their unique needs related to ageing and their symptoms (Alego et al. 2019; Bhattarai et al. 2020).

In another example, 53% of patients with CLBP revealed that the most common approach was using a Fitbit, which motivated them to be active (Amorim et al. 2019). Leese et al. (2019) concur with both Amorim et al. (2019) and Nordstoga et al. (2020), explaining that using a Fitbit enhanced patients' motivation to become more active. However, none of the studies surveyed here report levels of patient motivation before and after DHI implementation, so the overall effect of this facilitator remains unconfirmed. Sharing patients' own data with them encouraged them to become involved in self-management, so further confirmation of how motivation increases patient adherence is needed.

In parallel with the above findings, other studies have found that a lack of motivation hinders engagement with DHIs (Sparks et al. 2016; Zuidema et al. 2019; Hou et al. 2020; Nordstoga et al. 2020). Despite the motivation techniques used in the mHealth intervention, such as reminders, videos, and notifications, Nordstoga et al. (2020) state that a number of CLBP patients raised concerns about lack of motivation due to the frequency of the notifications which were excessively frequent. Likewise, Hou et al. (2019) show that a lack of motivation was a barrier resulting in poor compliance after lumbar surgery. Similarly, Zuidema et al. (2019) found a lack of motivation, although similar techniques, reminders and notifications were provided to enhance motivation among arthritis patients. However, both Zuidema et al. (2019) and Hou et al. (2020) provide the facilitating factors from the middle of the intervention periods so that the results might be different at the end of the intervention period.

2.15.1.6 Functionalities of the intervention (technology usability and technical support)

The usability of the intervention has been widely mentioned as a facilitating factor for end users (Button et al. 2018; Dhalberg et al. 2016; Selter et al. 2018; Alego et al. 2019; Nordstoga et al. 2020). In addition, DHIs delivered via mobile phone applications enhance patient engagement, which may be related to positive outcomes due to the features they provide to patients (Hewitt et al. 2020). A factor that may hinder the functionalities of DHIs is an overload of information and having several questionnaires to fill out. Two studies have shown that providing too much information and being too wordy are significant barriers to use (Alego et al. 2019; Button et al. 2018). However, Bhattarai et al. (2020) describe a need for greater variety in the intervention's resources and information, such as videos and diverse types of exercise. This contradictory result may be due to personal preferences related to the content of the intervention.

Using words that are difficult to understand seems to be a barrier to patient engagement. Cronstrom et al. (2018) mention that some patients had difficulty because the terminology used in the DHI was hard to understand, which may indicate that the intervention was not user friendly. Sparks et al. (2015), Caiata Zufferey et al. (2019) and Schulz (2009) report that many patients became confused due to wording and could not understand how the intervention worked. Frustration with technology due to technical difficulties constitutes another barrier. For example, log-in difficulties, inaccurate step counts and the false filling in of the diary are all factors that hinder patient engagement with DHIs (Kristjansdottir et al. 2011; de Vries et al. 2018; Nordstoga et al. 2020). All these factors must be considered when developing a DHI intervention.

2.15.1.7 Privacy and security

Privacy concerns commonly act as a barrier to the use of DHIs. In interviews of patients with RA, those who rarely used the internet indicated that it was scary and that they could not deal with it, because of privacy concerns (Zuidema et al. 2019). In Najm et al. 's (2019) survey, 23.8% of the respondents raised concerns related to data protection and privacy. Parker et al. (2013) reports a similar finding: 19.5% of older patients expressed concerns related to privacy when using the study DHI (among 41 patients). Results from previous studies could not be generalised primarily because several participants had no experience of using DHIs at the time of the study. In a usability study conducted by Kristjansdottir et al (2011), the participants did not experience any concern related to privacy and data protection, but the result could not be generalised due to the small sample size (n=6) and the nature of the usability study. Jakobsen et al. (2018) report that patients experienced problems in downloading the application to their mobiles and asked other people to do it for them, which might breach confidentiality. Therefore, privacy concerns should be considered in moving forward to ensure that patients are confident about this matter, particularly among older populations.

2.15.1.8 Knowledge and experience

Drawing from in-depth interviews, Zufferey et al. (2009) discovered that previous knowledge of the DHI and awareness of its potential benefits served as facilitating factors. However, the authors might reduce the credibility and rigour of their data analysis because they did not use a second reviewer to code the data (Pope et al. 2000). In addition, they did not measure the patients' previous knowledge of the DHI using an objective method. Only one of 22 papers mention this element, so the influence of this facilitator remains unconfirmed.

2.15.1.9 Cost and financial constraints

Najm et al. (2020) found that 21% of patients with RA were not willing to pay to use DHI. In addition, Parker et al. (2013) investigated experiences with DHI in a US study population, a country in which health service delivery is quite different to that in other countries. Patients were concerned about the cost of the intervention, indicating that, if the app were free, more people would be likely to use it (Parker et al. 2013). Therefore, countries' high-cost health services may act as a barrier to DHI use if payment is needed.

2.15.1.10 Perceived usefulness and positive outcome measures

A positive outcome from using a DHI improves the patient's engagement (Geraghty et al. 2019). To illustrate, in a phenomenological qualitative study conducted by Cronstrom et al. (2019), 19 patients with OA indicated that improvement in their symptoms was their reason for promoting and using the Joint Academy website. Bennell et al. 's study (2017) found facilitating factors that included patients' being able to understand their symptoms and act independently without visiting a GP.

However, Zuidema et al. (2019) found that negative feedback caused negative feelings and increased patient anxiety, inhibiting engagement with DHIs. The patients who did not use the DHI were anxious after filling out the daily self-report related to the level of pain. In addition, Hou et al. (2019) show that patients who did not complete the intervention gave as their reason a lack of improvement in their symptoms. By contrast, an improvement in the patients' symptoms, such as a reduced level of pain, was the reason given for not continuing in the study of Geraghty et al. (2019). However, those patients had a low to moderate level of pain at the baseline, so the results may not generalise to patients with severe pain. Nevertheless, a positive finding and improvement may be a facilitator of patients' engagement.

2.15.1.11 Access to the internet

Limited access to the technology within the clinical care environments may limit engagement with an intervention (Button et al. 2018; Kloek et al. 2020). This barrier exists not only in clinical environments but also extends to concerns about internet access and personal devices at home (Parker et al. 2013). Button et al. (2018) note that 12 patients who were eligible for their study did not participate due to insufficient access to technology at home. Similarly, both Kloek et al. (2020) and Bossen et al. (2016) report having patients who could not participate due to their limited access to technology. Parker et al. (2013) report that 13.3% of their RA participants declared that the DHIs required Wi-Fi or cellular data, which limited access to the intervention.

2.15.2 Providers' facilitators and barriers

Table 4 presents a comparative analysis of the facilitators and barriers perceived by healthcare providers in utilising DHIs. The data is represented as percentages, indicating how frequently each factor was identified as either a facilitator or barrier.

Table 5: Percentage of providers' barriers and facilitators

	Facilitators	Percentage%	Barriers	Percentage%
1-	Positive patients' health outcome	42%	Time constraints	24%
2-	Accessibility of patient data	25%	Workload and financial consequences	17%
3-	Training familiarity	17%	Negative patients' health outcome	17%
4-	Enhancement of patient-providers relationship	16%	Lack of accessibility of patients' data	12%
5-			Lack of familiarity	12%
6-			Support from organisation	12%
7-			Patient-provider relationship	6%

2.15.2.1 Accessibility of data

The accessibility of patients' data was one of the concerns related to professional healthcare providers. A provider needs to access patients' data and describes this accessibility as making him or her more likely to follow patients' progress more easily and enhance the usage of DHIs in clinical practice. The two studies that raised this concern were Bhattarai et al. (2020) and Leese et al. (2019). However, both Bhattarai et al. (2020) and Leese et al. (2019) might have raised this concern due to their little experience with providers utilising DHIs in clinical practice. Leese et al. (2019) recruited 34% of physiotherapists and occupational therapists who utilise Fitbit with patients in clinical practice. The author conducted a focus group that might be influenced by others who did not have experience with Fitbit.

Both Kristjansdottir et al. (2011) and Kloek et al. (2020) included physiotherapists who have dealt with web-based application directly to the patients' data and provide notes and feedback to the patients with widespread pain, knee and hip OA. A positive experience was noted, based on using a specific platform such as eExercie and Web-enabled mobile phone features. There was no concern related to the data access, as the intervention has already provided this option to the physiotherapist. Despite this finding, Eysenbah et al. (2016) revealed that physiotherapists have little or no control over the progression of their patients. This is due to the lack of providing which module patients have accessed and the lack of a personalisation process in the patient treatment plan. Therefore, the overall use of professional healthcare providers could be enabled if they had appropriate access to the patients' data.

2.15.2.2 DHI training and familiarisation (Usability and technical support)

Button et al. (2018) and Bhattarai et al. (2020) stated that healthcare providers must receive training before utilising this type of intervention and that they must be given sufficient time to familiarise themselves with DHI to enhance their skills in utilising it. Therefore, training before adopting and implementing DHIs can be considered a crucial facilitator for providers. Both Button et al. (2018) and Bossen et al. (2016) trained their physiotherapists in the platform before allowing them to use their DHIs. However, Bossen et al. 's (2016) training only lasted half a day, and Button et al. 's (2018) training period consisted of a one-hour presentation. The diverse types of DHIs the two studies used meant that the specific duration of the training was not standardised; thus, the best time for training in DHI usage cannot be confirmed.

2.15.2.3 Workload and financial consequences

Professional healthcare providers raised a concern regarding the workload that might occur when DHIs are integrated into clinical care (Bhattarai et al. 2020; Button et al. 2018; Kloek et al. 2020). However, Button et al. (2018) showed that the number of sessions provided to each of the two groups in their study (intervention and session, session only) was similar; thus, the DHI does not add to the workload. Hence, this potential barrier may lie in provider involvement but additional clinical evidence is required to confirm this. Despite the benefit DHIs offer regarding the minimisation of healthcare costs, Kloek et al. (2020) revealed that the private practice physiotherapists they surveyed experienced a loss of income because their face-to-face sessions were replaced with DHIs.

To illustrate, only 10 physiotherapists intended to use the DHI after the investigation concluded, whereas the other 113 physiotherapists did not intend to use the DHI. However, this was not definitely solely because of the loss of income. Other factors might affect the reduction

of use such as workload, needed more time and absence of guidelines. Kloek et al. (2020) only included self-employed physiotherapists; this might have yielded different results than if they had studied physiotherapists working for the NHS. Overall, physiotherapists may not use DHIs, which might act as a barrier to implementing these interventions in clinical practice, but the issue requires further exploration.

2.15.2.4 Time constraint

Insufficient time for consultations was cited as one of the major barriers to integrating DHI's interventions into clinical practice (Bhattarai et al. 2020; Button et al. 2018; Kloek et al. 2020). One clinician expressed that using the app and communicating with the patients often occurred outside of the clinic, which increased time commitment for the clinician (Bhattarai et al. 2020). It is possible that healthcare professionals might avoid providing this type of intervention due to the added workload.

Kloek et al. (2020) showed that less than 43% of physiotherapists surveyed (18 out of 49 physiotherapists) intended to utilise DHIs in the future. Although the researchers acknowledge that therapist advice to utilise the eExercise application during face-to-face sessions reduced workloads for therapists, insufficient time was raised as a concern (Kloek et al. 2020). Kristjansdottir et al. (2011) provided nurses' experiences while using a Web-enabled mobile phone to provide online feedback to patients with chronic widespread pain. The nurses mentioned that the time spent varied from 15 to 20 minutes daily and six to eight hours during the four weeks of the intervention period. In addition, three professional healthcare providers checked the note before sending it to patients, but the time for this was not mentioned. Therefore, time constraints could be an issue related to the professional healthcare providers to utilise DHIs with patients in clinical practice.

2.15.2.5 Organisational support

Button et al. (2018) prove that shifting work practices to enhance the utilisation of DHIs by providing sufficient time and increasing the length of the apportionment could be considered organisational support to reduce the workload for the professional healthcare environment. Despite the satisfaction of physiotherapists with eExercise interventions in Eysenbah et al. (2016), the physiotherapist raises a concern related to the suitable integration of DHIs into clinical practice. Furthermore, the absence of the standardisation and the guidelines from national eHealth could be a barrier to utilising eExercise, as shown by the experiences of physiotherapists in Eysenbah et al. (2016). This factor related to organisational support should be considered in further research to prove this result.

2.15.2.6 Positive and negative patient health outcomes

Several studies reported that healthcare professionals expressed concern about the patients' feelings and the harm that could occur if patients could not manage its application, including a provider's negative emotions if patients were not progressing or submitting reports on their progress (Bhattarai et al. 2013; Button et al. 2018; Leese et al. 2019). However, both Bhattarai et al. (2020) and Leese et al. (2018) included professional healthcare with limited or no experiences with using the DHIs in a clinical setting. Therefore, the lack of knowledge behind the benefit that DHIs might support for both patients and providers could be limited due to a lack of experience.

In addition, Button et al. (2018) conducted interviews after four weeks of using the DHIs. The short-term period of using DHIs might not supply an in-depth experience, as utilising DHIs takes a long time for adoption. Thus, the negative thought processes patients may experience from engaging with DHIs should be understood more from high-quality research to provide

this evidence to professional healthcare providers. Both Bhattarai et al. (2020) and Eysenbah et al. (2016) show that DHIs should provide value for use, and this could be by confirming evidence or through the enhancement of patient adherence to the intervention. Thus, evidence that approves the enhancement of the outcome from using DHIs could act as a facilitator to professional healthcare providers.

2.15.2.7 Patient-provider relationship

Therapists and nurses demonstrate that DHIs could enhance the interactive relationship with patients (Kristjansdottir et al. 2011; Leese et al. 2018). However, Button et al. (2018) reveal that the most common concern related to physiotherapists is that they should maintain good communication with patients.

2.16 Discussion

From the evidence above, it can be clearly seen that many studies have investigated the utilisation of DHIs among people with MSK in different methods. The objective of the current study is to identify the experiences of both patients and professional providers, which seems to indicate the satisfaction associated with various DHIs. However, the usage rate of this intervention was limited. Therefore, understanding critical factors could improve the uptake and usage for patient with MSKs and professional healthcare, by highlighting the findings of this scoping review. In this section, four major headings will be discussed based on the aim of the scoping review. First, the method of measuring utilisation and usability of DHIs for self-management among MSKs in earlier studies was mapped. Second, reporting the barriers and facilitators from both patients and providers experience. Third, the gap in the literature was addressed and, finally, the limitations of the current study.

2.16.1 Methods of measuring usability and uptake of DHIs

The methods of measuring the utilisation varied and needed to be standardised to provide a clear method that might be effective. The heterogeneity of measuring usability and uptake makes it difficult to compare and identify the best method; however, the aim of this scoping review was to map this method, not to identify the best methods. Four types of methods were identified: 44% of the studies utilised a semi-structured interview, while 29% of the studies reported an analysis of the web–mobile-based application, and 20% of the studies utilised a questionnaire, finally only 7% of the studies used a focus group. This finding was consistent with other studies that identified the heterogeneity of measuring usability (Davis et al. 2020; Zapata et al. 2015). Most of the studies conducted measured the usability of DHIs at the end of the intervention period, and no studies measured usability at the early stage of utilising DHIs. Another issue related to the analysis of mobile web usage was that two authors measured the number of completed assessments, while another author provided a reward to complete all assessments, which provided a selection bias (Bennel et al. 2018; Trudeau et al. 2015). Thus, measuring usability could not relate to the usefulness of the intervention and may not be a reliable method with reward techniques.

Regarding the questionnaire method, few studies used a valid questionnaire (Eysenbah et al. 2016; Kloek et al. 2018; Norsdigan et al. 2020). Other studies employed a Likert scale, which might be not valid due to the limited psychometric properties of the instrument (Porten 2015). System Usability Scale (SUS) is a subjective assessment of usability developed by Brooke in 1986, and it is considered a valid and reliable tool (Mack et al. 2009). The benefit of usability is to establish the importance of the intervention when delivering a product choice (Mock et al. 2009). Therefore, to provide the importance of such DHIs for patient or clinical practice, the

SUS tool could be essential. Despite this benefit, a limitation of the questionnaire acknowledges that understanding issues related to the intervention could be difficult. Davies et al. (2020) argued that a questionnaire could not give a specific issue related to the intervention, which differs from other types of methods.

Another issue identified in the online questionnaire was that this method may not work well for online DHIs, if participants do not utilise the DHI due to a lack of appropriate technology, and that they could not access the survey, resulting in selection bias (Gosall 2015). Hou et al. (2019) argued that a paper-based questionnaire that utilised in the clinical environment was the reason for the high attrition rate and recommended an online survey to address this issue. Thus, providing both online and paper-based questionnaires might be an appropriate measure of the usability method.

One common method of measuring usability was a semi-structured interview. Although this method could gather more information, it is considered time-consuming and costly (Davis et al. 2020). The focus group was the method least utilised in the studies, and this is consistent with Davis et al. 's (2020) finding. In addition, a scoping review conducted by Maramba et al. (2019) highlighted that automated methods have not been utilised during the evaluation of health apps, and this has not been gained in the DHIs among MSKs. Both Maramba et al. (2019) and Davis et al. (2020) show that the better approach to measuring usability is by conducting various methods simultaneously, a task completed by one researcher (Norsdigan et al. 2020). Thus, to enhance the usability of the intervention, conducting different methods of measurement could solve this issue.

2.16.2 Barriers and facilitators' factors for utilising DHIs

Regarding the barriers and facilitators from the patient's experiences, the frequency of the facilitators consists of the communication influence of the patient-provider $n=9$ and motivation $n=9$, perceived usefulness $n=7$, functionalities of the intervention $n=6$, physical characteristics $n=4$, and training and familiarity $n=3$ and for each technical skill $n=1$, and previous knowledge $n=1$. The frequency of patients' barriers to utilising DHIs are lack of patient-provider communication $n=10$, functionalities of the intervention $n=10$, lack of motivation $n=4$, limited access to the internet $n=4$, concern about privacy and security $n=3$, negative outcome measure $n=3$, lack of technical skills $n=3$, concern about cost $n=2$ and a lack of training $n=1$.

The barriers and facilitators related to professional healthcare and the frequency of the facilitators, are positive and negative patient health outcomes $n=5$, accessibility of patients' data $n=3$, training and familiarity of the intervention $n=2$ and the enhancement of the patient-provider relationship $n=2$. The frequency of the barriers is time constraints $n=4$, workload and financial consequences $n=3$, positive and negative patients' health outcome $n=3$, lack of accessibility of patients' data $n=2$, lack of familiarity $n=2$, support from organisation $n=2$ and patient-provider relationship $n=1$.

The key to facilitators associated with the patient was patient-provider communication and motivation (44%), followed by perceived usefulness (18%). These factors probably related to the construct of self-determination theory, namely relatedness and competence (Ryan and Deci 2000). Relatedness means that the patient is valued by others and connected, which is the case for patient-provider communication. As the lack of communication and support were linked as a hindrance to the patients, the high attrition rate was associated in the studies that did not give a support need to the patients (Safari et al. 2020). The critical barrier mentioned above

highlights that a high frequency of studies cited lack of communication as a barrier to utilising DHIs. This can be clarified by the lack of relatedness that impacts patient engagement with DHIs. Furthermore, competence implies not only being capable but also possessing the mastery required to perform an action (Deci and Ryan 2000) and is associated with the perceived usefulness and positive outcome that was addressed. All these concepts reflect the psychological needs that enhanced motivation and maintained engagement with the intervention (Slovinec D'Angelo et al. 2014).

Supportive communication between patients and providers varies in delivery, which may also affect the uptake of the intervention. For example, some studies use a chat feature (Selter et al. 2018; Dahlberg et al. 2016; Cronstrom et al. 2019; Jakobsen et al. 2018; Schulz et al. 2006; Hou et al. 2020) while others use a telephone feature (Amorim et al. 2019; Geraghty et al. 2018), personalised text message (Kristjansdottir et al. 2011; Nordstoga et al. 2019) or reminder email (Lorig et al. 2008). Another form of support was simply checking the patients' self-diary without any communication or guidance (Hou et al. 2019). All these features could affect patient-provider communication and alter performance, so further investigation is needed.

For professional healthcare, the key facilitators were to identify the usefulness of the intervention for the patients' health outcomes, which also related to the concept of competence. However, the concept of relatedness was limited and might function as a barrier for professional healthcare providers. This reflects the fact that might be the reason for the limited engagement of patients with DHIs, as relatedness is considered an important factor that facilitates patient engagement. Street et al. (2009) revealed that patient-provider communication can predict patients' health outcomes. Similarly, a meta-analysis conducted by

Kelly and DiMatteo (2009) showed a high correlation between physician communication and the enhancement of patient adherence. Despite the variation of delivery of patient-provider communication, the concept of communication was in line with the current finding of this review. Exploring patient-provider communication that utilises support and effort through DHIs is worthwhile because this approach may differ from traditional face-to-face consultations.

Comparing the findings of this scoping review with others in the literature was limited due to the lack of research that has addressed this issue among MSKs. However, other systematic reviews that identify barriers and facilitators for patients with different conditions yielded results almost similar to the result of the scoping review. To illustrate, the level of education, the stage of the condition, patients' expectations, lack of skills and motivation were addressed in Ross et al. (2016), Vis et al. (2018), Granja et al. (2018) and Aref-Adib et al. (2019). These studies consider the hindrances and enablers for the implementation of mHealth in clinical practice as the central concepts investigated in people with bipolar disorder, mental health, and part of a non-specific population. Patients with different conditions need other support; therefore, the barriers and facilitators could vary between patients with MSKs and mental health conditions.

For professional healthcare providers, the previous barriers and facilitators were workloads, beliefs, skills, training, financial incentives and undefined roles and responsibilities, as mentioned in a systematic review conducted by both Ross et al. (2016) and Granja et al. (2018). These are similar to those in the scoping review presented here, and the possible reason for that is the professional healthcare providers working in clinical practice probably need organisational support to utilise technology in practice. However, Ross et al. (2016) reveal that

clinical experiences, age, sex, and nationality may all affect the performance of professional healthcare providers. Indeed, this was not identified in the current study, as only six studies investigate professional healthcare providers. Kloek et al. (2017) was the only one to examine the physiotherapist's personal characteristics and identify no significant distinction between users and non-users. However, Kloek et al. (2017) include only age and sex, without considering other factors. Thus, lacking studies concerning professional attitudes and beliefs reflect that DHIs, in particular self-management for MSKs, are not well established. More studies are needed to highlight these factors.

The findings of the review could also be associated with theories other than self-determination, which is the UTAUT. The conceptual module has been developed to understand the end-user intention to use a new technology (Venkatesh et al. 2016). Previous studies did not consider this theory as a theoretical framework for understanding several concepts that might impact the utilisation of DHIs. The finding of the current review was in alignment with some constructs of the UTUAT for both patients and professional healthcare providers. For instance, a positive outcome was associated with the performance expectancy construct, and for provider experiences, the construct effort expectancy was related to the barrier of the workload addressed. It reflects how the end user could utilise and identify more hindrances related to DHIs.

2.16.3 Gap in the global literature

Based on the review and the studies included, more information is needed relating to the professional experiences of healthcare employees who utilised the DHIs and integrated a digital self-management during clinical practice. The frequency and the dose offered by the providers were not precise. Therefore, to provide a standard for the policymaker and organisational support, the knowledge behind this maintenance needs to be explored. As the delivery was varied, some were utilising a blended approach, and some were sending a message or providing a short phone conversation. By understanding the support and effort provided by the professional healthcare provider, new evidence might be developed to help enhance the utilisation of DHIs.

Most of the evidence related to the experiences was gathered after both feasibility and pilot studies (Aleg et al. 2017; Bhattari et al. 2020; Button et al. 2018; Bossen et al. 2016; Constrom et al. 2019; Geraghty et al. 2018; Jakobsen et al. 2018; Sparks et al. 2015; Mollard et al. 2018; Zuferey et al. 2009) or as a short questionnaire after the RCT to identify their satisfaction and, as feedback, follow up after six months (Bennell et al. 2017). This might limit the in-depth knowledge related to experiences after a long period by using observation or ethnography research to understand and raise other factors associated with both professional healthcare and patients.

Findings from this scoping review highlight several factors related to the work culture common to healthcare services, such as workload and time constraints. However, there were limited insights regarding cultural and religious aspects which could be critical for the utilisation of DHI among populations with diverse cultural and religious backgrounds. Ly et al. (2017) investigated the effect of culture and religion on physicians in their study, but they did not consider patients with MSK conditions. This study, conducted in a country with an Islamic religious and social culture (Senegal) revealed the negative impact of religion and culture on patients' use of telemedicine (Ly et al. 2017) and it demonstrated the importance of considering the cultural and religious views that can influence individuals' beliefs concerning the use of DHI. This perspective was not present in the current scoping review and this absence could potentially be attributed to the specific countries where these studies were conducted. Most of the studies in the current scoping review were conducted in a Western context with a variety of healthcare systems and cultural norms related to the use of DHI for managing populations with MSK conditions. It is important to note that the valuable factor identified by these studies reflects global DHI use among MSK patients and healthcare providers. However, the direct application of these practices in a Saudi context may be challenging due to several factors such as differences in healthcare systems, religious beliefs and social and cultural norms. The findings from the scoping review indicate a significant gap in the current research landscape and demonstrate the need for more culturally sensitive studies to explore the use of DHIs in diverse settings, such as Saudi Arabia. Doing so may help to enhance our understanding of the current use of DHI among MSK patients and physiotherapists and facilitate the exploration of the cultural and religious impact of these practices, thereby helping to fill a research gap and guide future studies in this area.

2.17 Limitations

The limitation of this scoping review was the lack of a second reviewer, which maximises the strength of such a review, as recommended by Peters et al. (2020). Moreover, the quality of the research was not an essential step in the scoping review. Low-quality studies were included; this might weaken the finding of the result. However, the risk of assessment was applied to interpret the results from the previous researcher very cautiously. The reviews included only studies published in the English language which might reduce access to essential information and introduce language bias. Furthermore, other factors could affect utilisation, such as the recruitment process and content of the DHIs were not investigated. Due to the complexity of DHIs' engagement, other factors should be investigated to provide comprehensive information. However, content analysis based on the factors that hinder or enable the utilisation of the DHI among healthcare providers and patients with MSK conditions was a comprehensive process in this review. Thus, the findings could be utilised to guide further research with different methodological approaches.

2.18 Implications and further research

The implications that arise from this review indicate evidence is needed relating to the experiences of the healthcare provider to get deep knowledge, skills and attitudes regarding the professional healthcare provider. This would enhance the implementation and integration of DHIs in clinical practice. In addition, a reliable and valid measurement tool for usability might enhance the reported measure during and after the intervention, which could also be utilised during investigations. Furthermore, the amount of dosage related to supporting patients via professional healthcare is limited, and the relationship of the dose effect to the outcome measure was also inadequate. Hence, providing this information would enhance knowledge and improve the utilisation of DHIs.

2.19 Summary

Based on the previous evidence provided, various methods have been employed to explore usability. It can be concluded that adopting a range of methods to investigate the usability and use of DHI could highlight more concerns related to DHIs. Furthermore, numerous barriers and facilitators have been identified which could significantly influence the adoption of DHIs among patients with MSK conditions and healthcare professionals. Among these factors, communication with healthcare professionals emerged as a key facilitator for patient engagement in DHIs. Additionally, motivation was found to play an important role in encouraging patients' use of DHIs. The primary facilitators and barriers associated with healthcare professionals' use of DHIs were identified as workload and time constraints. Additionally, a notable gap in the literature is the exploration of how much effort, support, and communication healthcare staff provide to patients when using these technologies. Investigating experiences and elements that align with constructs within the UTAUT could shed light on this issue. Specifically, focusing on physiotherapists can enhance the understanding of their experiences with DHIs in daily clinical practice. Therefore, it is essential to address these challenges to enhance the use of DHI among professional healthcare providers and MSK.

Chapter 3

Methodology

Chapter 3: Methodology

3.1 Methodology and framework

The findings from the scoping review identified a research gap and a need to explore the experiences of both physiotherapists and MSK patients regarding DHIs use in Saudi Arabia. The area to be investigated will be based on the UTAUT framework, which will establish the factors that impact utilisation and acceptance of DHIs and identify the physiotherapists' role in providing DHI self-management for patients with MSK conditions. This chapter begins with aligning the research aim with the selected paradigm and the study design. I will define different research terms to provide a clear philosophical position for the study and demonstrate the rationale for selecting the research design.

3.2 Introduction

It is essential to recognise similarities in all methodologies, specific procedures, distinct methods and philosophical assumptions when defining a research methodology (Creswell 2018). To answer a research question, the researcher must identify the most suitable paradigms for guiding the study. Identifying the paradigms is crucial because it clarifies the process of selecting a methodology and justifies the choice of research design. This is because a paradigm (the philosophical stance adopted by the researcher) establishes an overarching belief system that guides and shapes the methodological framework (Creswell 2018). Several scholars in the field of research methodology, demonstrate that a paradigm is a world view and that an individual's assumption, which is based on the ontology, epistemology, axiology and methodology related to the basement of the belief system, is associated with this view (Creswell and Plano Clark 2017).

Ontology, a branch of philosophy, concerns the study of existence or the nature of being. (Neuman 2013). By contrast, epistemology is concerned with knowledge and understanding what we know (Neuman 2013). Teddlie and Tashakkori (2009) state that axiological assumptions pertain to the significance of values in conducting study, which could be either value-bound or value-free. The latter term is related to the assumption's drive and is the basis for this broad approach (Welford et al. 2011). Epistemologies, ontologies, axiology and methodology provide the assumptions on which philosophical suppositions are based (Crotty 1998). Indeed, all these assumptions provide the belief, processes and language that structure scientific enquiry (Weaver and Olson 2006). Thus, it is essential to understand these concepts to select an appropriate methodology, which will provide coherence and rigour to the enquiry (Houghton et al. 2012).

3.3 The paradigm of the research

Four primary paradigms have been identified for diverse types of research: positivist, constructivist, participatory and pragmatist.

3.3.1 Positivist paradigm

The research in physiotherapy has been largely directed by quantitative studies that could be generalised and repeatable for biological pattern occurrence (Herbert 2005). Several paradigms can be associated with quantitative design, but the most common paradigm based with quantitative research is the positivist paradigm (Sale et al. 2002). It has been considered that the positivist paradigm was the basis for scientific research for a period (Krauss 2005; Ponterotto 2005). The ontology basis for the positivist paradigm assumes that a single reality exists and can be seen in the physical world (Teddlie and Tashakkori 2009). The assumption of positivism came from the idea that theories govern the world, and that social events could be

understood by exploring these theories (Cresswell 2003). To illustrate, numerical data are used to identify cause and effect, making measurement results objective (Tashakkori and Teddlie 2003). This type of research is often based on a positivist paradigm, which indicates that knowledge is understood by experimental design (Howell 2016). The justification for utilising this paradigm often becomes the need to understand the truth through rules, laws and theories (Guba and Lincoln 1994; Park et al. 2020). However, this paradigm is limited in utilisation due to its weakness, particularly in social sciences, because human actors cannot be separated from social phenomena (Bryman 2016).

Previous research has selected this paradigm to explore DHI by conducting experimental studies based on theories. The main aim of previous studies was to understand the 'what' question under objective epistemology (i.e., identifying the level of pain, self-efficacy and other outcome measures before and after utilising DHIs). The positivist enquirer's role is to identify reliable patterns on which healthcare providers can take action to utilise DHIs for specific people (Murray et al. 2016). The researcher could identify differences and therefore provide evidence-based data for utilising DHIs. However, the questions of 'why' and 'how' cannot be answered via this type of research because the utilisation of DHIs could be influenced by several internal and external influences, like an individual's experiences, intention, culture and beliefs (O'Connor et al. 2016; Greenhalgh et al. 2017). Although a positivist paradigm can provide valuable knowledge for objective and generalisable findings, it was not chosen for this study. The complexity of the DHIs requires an approach that can capture multiple dimensions; therefore, another research paradigm that allows for a more comprehensive exploration of complex phenomena was believed more appropriate.

3.3.2 Constructivist paradigm

An alternative paradigm is constructivism, which suggests that knowledge exists in reality without being measured objectively (Guba and Lincoln 1989). The ontological assumption for constructivism considers that realities are numerous and can be measured subjectively (Nicholls 2009). Creswell and Plano Clark (2011) support this paradigm and the belief that reality is driven by an individual's social interaction and personal experience. This paradigm rejects positivist claims and believes that reality can be determined by subjective measures of individual social construction (Parahoo 2006). To illustrate, the social construction and personal experiences of individuals drive their reality by constructing a mentality (Creswell and Clark 2011). Engaging individuals with their own environment could acknowledge the understanding of their behaviours (Parahoo 2006).

Constructivist paradigms provide insight into the knowledge that could be gained from learning 'why' rather than 'what', as in the positivist paradigm (Creswell and Plano Clark 2017). This paradigm is appropriate if the researcher needs an in-depth understanding of the enquiry, such as a person's satisfaction and personal experiences. Through qualitative research, social interaction and other behaviour changes can be identified by interviewing or observing an individual's perception and experiences. Therefore, when studies use this paradigm, they aim to refer to social constructions (Robson 2011). Studies that focused on this paradigm explained that reality exists based on social achievement between the researcher and the individuals or groups in a social context (Guba and Lincoln 1985; Charmaz 2014), which would make

selecting this paradigm an appropriate choice for achieving an in-depth understanding of the factors that limit an individual in utilising the DHI.

This attracted my interest and the extensive understanding of insight obtained from the reading inspired me to contemplate designing a study that would gain from the detailed insights offered by qualitative approaches, including the potential for expansive results, which was especially interesting. The nature of the physiotherapists' views while utilising DHI, have not been subject to previous research. However, this paradigm hinders the ability to gain insight into the most important factors that limit both physiotherapists and MSK patients. It seems that it would be unfruitful to utilise this paradigm with the researcher's aim, which is to understand the most common factors that physiotherapists and patients face when utilising DHI, an aim that can be met via quantitative research. Therefore, I considered if a different approach might offer a novel viewpoint of the research problem.

3.3.3 Participatory paradigm

The participatory research paradigm implies that knowledge is firmly based on the researcher's and the participants' critical subjectivity and practical thought (Howell 2016), and it is often related to socio-political issues (Creswell and Clark 2018). Often known as the transformative paradigm (Mertens 2007), the participatory paradigm could be considered if the researcher aims to understand the broader political and organisational factors that might influence utilising DHI. Despite the worthiness of objective separation and personal interaction, the focus on uncovering political factors was beyond this study's scope. This paradigm seems to be relevant for completing a picture of utilising DHI in terms of political and environmental factors. However, the current study's context is to explore barriers and facilitators from physiotherapists' and patients' perspectives rather than to investigate their origins. In addition,

the research question focuses on the research problem, and the pragmatic paradigm is a problem-oriented philosophy. Therefore, it might provide a more appropriate theoretical framework, given the nature of the current study.

3.3.4 Pragmatism paradigm

The pragmatism paradigm originated from the work of Peirce, James and Dewey (Cherryhomles 1992); Peirce being considered the "father of pragmatism" in the 1870s (Thayer 1981). James and Dewey's work has modified the pragmatic theory derived from Peirce's work and responded to the criticism of the theory. There are many forms of pragmatic philosophy, but the standard criteria for pragmatism arise from actions, situations and consequences of the condition (Morgan 2007).

Many researchers consider pragmatism to be a primary theoretical framework for mixed-method design (Biesta 2010; Mackenzie and Knipe 2006; Morgan 2007; Yvonne Feilzer 2010; Scott and Briggs 2009). The pragmatist viewpoint argues that nature in the sense of the environment is of little practical interest and despite the wide range of views on the nature of reality within pragmatic philosophy, pragmatists generally prefer action to philosophising (Teddlie and Tashakkori 2009). To illustrate, Rorty (1981) specifies that pragmatists prefer noteworthy, practical findings to abstract philosophy. Therefore, pragmatism's concern is to identify what works and create a solution to the research problem at hand. Thus, multiple methods could be used to learn about and better understand the problem (Creswell 2007). In addition, the philosophy of pragmatism is considered to be a flexible method design that is often chosen to help answer research questions and has no loyalty towards specific philosophical assumptions (Hesse-Biber and Johnson 2015). The current research aims to

identify the limitations of not using DHI, which focuses on practical solutions, and on the philosophy of pragmatism, which matches this study's nature.

In pragmatism, reality is considered to be initiated by individuals acting in the world, so reality exists based on human experience and is concerned with solving practical issues. In other words, from a pragmatic perspective, reality can be either single or multiple (Creswell and Plano Clark 2007). Pragmatism views the world as singular based on existence theory and multiple in its consideration of personal views. Reality exists but is interpreted differently by individuals; more specifically, pragmatism focuses on "what works" rather than absolute inquiry and real objectivity (Morgan 2014). Additionally, pragmatic philosophy is based in the words "it depends", and in pragmatists' perspective, knowledge is to understand phenomena and not to conclude that there is a single truth. More specifically, the truth might change with time, and, therefore, people's actions will change; the investigator must understand the consequences of these actions to understand truth as utility in practice.

From an epistemological perspective, pragmatists believe that a relationship of either objectivity or subjectivity exists between researchers and participants (Creswell and Plano Clark 2011). In addition, knowledge is produced by the practical benefits and consequences of actions (Creswell and Plano Clark 2011; Teddlie and Tashakkori 2009). From Dewey's point of view, knowledge is gaining from the outcome of the competent inquiry (Hickman 1992). The legitimate nature of intended knowledge in pragmatism exists alongside actions, and they cannot be separated from each other; this is because beliefs depend on actions, and actions occur because of people's beliefs (Morgan 2014). Thus, pragmatists' concern with the practical

concepts learned from specific phenomena replaced the legitimate nature of knowledge (Hickman 1992). Morgan (2014) states that either subjective meaning of observable phenomena can postulate sufficient knowledge if they answer the research questions or fulfil the study's objective. Thus, providing an answer to the research question through either epistemological view can provide legitimate knowledge.

Within the paradigm of pragmatism, the researchers' values are crucial and lie in what they research and how they conduct research (Houghton et al. 2012). Teddlie and Tashakkori (2009) confirmed this and demonstrated that the researcher's feelings towards the issues and the essential aspects that need to be discovered, and their personal values, influence their decisions about what to study and how to conduct their studies. This axiological perspective within this paradigm corresponds to the personal research perspective, as a researcher's value regarding boundaries on the use of DHI in Saudi Arabia trigger them to investigate and discover this type of limitation. In addition, from a practice-based perspective, an understanding of the factors limiting physiotherapists' and patients' use of DHI will be gained by understanding the actions and consequences of these activities in practice. Thus, a participant's values play a role when using DHIs. The concept of inquiry and the central role of beliefs, as stated by Dewey, fit well within this study. The researcher's values can be either explicit, as in the constructivism paradigm, or hidden, as in the positivism paradigm.

To produce legitimate knowledge, researchers must select valid and appropriate methods, which would be equivalent to the methodology of the research sciences. The selection of methods from a pragmatic point of view is based on what will work best to answer the inquiry

(Creswell and Plano Clark 2017). As Creswell (2018) states, the criteria to decide the suitability of the methods should be determined by evaluating how to achieve the study's purpose. More emphasis is placed on why a specific method should be selected over others in the pragmatic paradigm (Morgan 2014). In addition, several researchers argue that under the pragmatism paradigm, mixed methods design can develop more comprehensive and valuable results due to better integration of the data products through the use of multiple methods (Johnson et al. 2007; Alise and Teddlie 2010; Teddlie and Tashakkori 2009; Morgan 2007). Morgan (2007) demonstrates that the researcher's beliefs affect the selection of the methods according to their stance on the workability of these methods. Through a pragmatism paradigm, the researcher can choose the most suitable and effective methods by evaluating the effectiveness of each method under the selected paradigm (Shannon-Baker 2016).

Criticism of the pragmatism paradigm exists; for example, one of the criticisms is that the paradigm cannot explain the mechanism and that no explanatory foundation can be provided by adopting the pragmatism paradigm (Hall 2012; Taylor and Medina 2013). In other words, a researcher could advocate that a particular solution might work in a specific context but that there is limited explanation for why the solution worked (Hall 2012). This argument could be made if the researcher is utilising other types of mixed methods approaches (e.g., convergent mixed methods). By utilising a convergent mixed method, the researcher can confirm the data using different methods but it is also possible that no confirmatory results will be developed (Morgan 2014). Therefore, limited integration and challenges in understanding how or why a particular phenomenon occurs could present issues. Considering this criticism, an explanatory sequential mixed-methods approach will be adopted in this study. Creswell 2003 states that qualitative results can explain data in more depth, as the research question can be developed

after analysing the results from the quantitative methods. This could be the answer to the criticism of a limited mechanism and provide an explanation for the results.

The research question of the present study focuses on the barriers to and facilitators for using DHIs for MSK in Saudi Arabia. By examining the use of and limited engagement with DHI of both patients and physiotherapists, the aim is to identify the practical issues which fit within the pragmatic view. The researcher can decide what type of methods to use, drawing from both quantitative and qualitative designs, which may help produce comprehensive findings by eliminating the weaknesses and enhancing the strengths of each method. Pragmatism is the most common paradigm framing the choice of mixed-method approaches (Creswell and Clark 2018). The interpretation of research findings also reflects the researcher's paradigm and is an essential element of the research's philosophical assumptions. The issues related to the interpretation of the research will be discussed later in relation to the challenge of applying mixed methods to research.

Polit and Beck (2014) state that researchers usually select the paradigm that most closely resembles their view of the world. Pragmatism is a paradigm that resonates personally and would enhance decision-making throughout the research process. A pragmatic approach will be taken because of its focus on the research problem, as pragmatism is a problem-oriented philosophy. In addition, Dewey's statement that pragmatism concerns practical issues suggests that it could be used to explore barriers to and facilitators of the use of DHI to make it more practically useful. Therefore, this study was designed based on the pragmatist paradigm, which will be used to explain the methodology I adopt in the following section.

3.4 Mixed methods design

Selecting a research design involves several processes that the researcher needs to identify in order to select the design that is most appropriate. In other words, the critical precursor to deciding the structure of a research investigation is the purpose of the study, as stated by Creswell and Plano Clark 2018. Several scholars have demonstrated that a research design is driven by the research's central question and purpose (Tashakkori and Teddlie 2003; Creswell and Poth 2018). Thus, the study's research question and purpose play a significant part in the researcher's selection of the design.

The study's purpose is to identify the factors that limit the utilisation of the DHIs, and this could be done by a cross-sectional study, such as a survey. However, by using other research methods, such as a pure quantitative cross-sectional study based on statistical analysis, the findings could be generalised. While this could answer some of the research questions, it would be much less effective in assessing the experiences of both patients and physiotherapists that lead to less or more engagement with the DHIs. As for pure qualitative research based on the interpretative or constructivist paradigm, this could help develop rich knowledge by considering patients' and physiotherapists' experiences. However, the researcher would not be able to gain the appropriate knowledge, as engagement with the DHI is a complex phenomenon, with more than one layer that requires to be understood. Therefore, other types of research methods, such as mixed methods research, should be considered to provide the proper answer to the research questions.

Several definitions have appeared for mixed methods study. In the current project I have followed the explanation of mixed methods study as research in which “*a researcher or team of researchers combines elements of quantitative and qualitative research approaches (e.g.,*

uses of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the purposes of depth of understanding and corroboration” (Johnson et al. 2007, p.123).

According to Creswell (2003), three main types of mixed methods can be conducted. Convergent mixed methods involve collecting both quantitative and qualitative data at the same time. Despite the popularity of this kind of method, it is challenging and requires skill. Also, integrating the data for each phase of this type of research is acknowledged to be challenging. It is argued that the data may not be allied, and that no straightforward integration of the data may be possible. Therefore, more phases may be required to address the study queries. The second type is the transformative mixed methods design, where a quantitative method such as a cross-sectional survey is used alongside open-ended questions for qualitative data collection. While this can produce valuable insights, it may not be the most suitable for the current context. The depth of qualitative data might potentially be compromised because it relies on participants' willingness and interest to provide detailed responses to open-ended questions in a survey format. Considering these concerns, I decided that other research designs and methods would align better with the specific context of the current study.

Furthermore, the third type of mixed methods is the sequential mixed methods approach, particularly in an explanatory or exploratory design (Creswell 2003). The exploratory sequential mixed methods approach, which primarily aims to explore a single phenomenon in depth (Creswell 2003), did not align with the current research questions. The objective was not just to explore one aspect but rather multiple factors that might hinder both participant groups. When considering the broad range of potential factors and limited data regarding DHIs in Saudi Arabia, starting with qualitative research could limit a comprehensive understanding of these issues. Thus, after carefully considering each approach for compatibility with this current

study's research question, context, and objectives, an explanatory sequential mixed method design would offer greatest insight to the research question.

An explanatory sequential mixed methods approach is used in the current study. This type of design was followed by Creswell and Plano Clark (2011). This design includes a mixed quantitative and qualitative design, starting with the quantitative part and followed by the qualitative part. Phase One involves a cross-sectional design, which includes a survey that describes the factors at one point in time for both physiotherapists, and the patients with MSK conditions receiving treatment. Despite the limitations of this design, it can investigate many participants and identify a phenomenon that can be generalised. However, the findings from a cross-sectional study may be limited, and a clear phenomenon may not be able to be identified. From a pragmatist perspective, it is believed that reality exists but may be interpreted differently by different people (Morgan 2014). This can be researched by conducting qualitative interviews to discover different perspectives behind the phenomenon. Therefore, a semi-structured qualitative interview design will be employed to understand in-depth the phenomenon that needs to be discovered.

Overall, based on the previous definition, it can be clearly seen that there is a rationale for selecting a mixed methods study. The research questions cannot be answered by using just one type of design. For instance, a cross-sectional study could be used to identify the most common factors that may limit or facilitate the usage of the DHI among both patients and physiotherapists. However, the reasons behind the possible factors cannot be identified without a qualitative part. Therefore, to provide a clear answer to the research questions, it is recommended to mix both types of research design (Branen 2005; Bryman 2006). When selecting a research design, it is essential to consider the research questions, as Creswell (2014)

points out that not all types of research questions can benefit from a mixed methods design. Therefore, the rationale for selecting a sequential explanatory research design is the limited data available for the utilisation of the DHI by physiotherapists in Saudi Arabia as a self-management approach for patients with MSK. Explorations of the current use of the DHIs could be identified through a large sample based in the two main cities in Saudi Arabia. Although the large amount of time required is a common disadvantage when conducting mixed-methods research, this approach is more straightforward and could provide credible findings.

3.5 Theoretical framework

Different theories have been used to explore the acceptance and utilisation of technology (Sun and Zhang 2006). DHI can be associated with various theories as it is complex in its composition. UTAUT was used along with cultural construct as credible data on DHI usage among MSK patients and physiotherapists. Justification for applying these theories can be provided by outlining other theories which could apply to the use of new technology. Several theories could potentially be applied to understand the use of new technology, such as the Theory of Reasoned Action (TRA), Social Cognitive Theory (SCT), the Theory of Planned Behaviour (TPB), the Technology Acceptance Model (TAM), and the motivational model (Bandura 2001; Davis 1986; Fishbein and Ajzen 1975; Venkatesh et al. 2003). All of these theories can provide valuable insight into individuals' views regarding technology use.

Fishbein and Ajzen (1975) developed TRA to understand an individual's voluntary intentions that impact performance when using technology and stated that attitude and subject norms could predict intentions to use technology. Attitude can be defined as an individual's feelings about behaviours; having a positive outlook towards technology use leads to easier adoption

(Sheppard et al. 1988). The second construct involved individuals' perceptions regarding people they consider essential and their attitudes about technology use, though using TRA cannot reflect mandatory contexts (Brown et al. 2002). Given the specific context of this study, the MOH in Saudi Arabia mandates DHI use. Therefore, TRA may not be suitable. When technology use is mandatory rather than voluntary, behaviour is not solely driven by individual choice and intention (Brown et al. 2002). Similarly, the TAM, developed by Davis (1989), consists of two constructs: perceived ease of use and perceived effectiveness. While this theory has been extensively applied to illuminate end-user perspectives towards technology use, it can be argued that its focus is predominantly on technological factors (Lee et al. 2003). This emphasis limits the insights into other relevant factors that need to be addressed for a comprehensive understanding of factors hindering end users from engaging with technology.

In addition, SCT, another widely discussed theory regarding individual behaviour, is often used to predict social behaviour in individuals (Bandura 2001). Bandura (2001) proposed this theory that provides three constructs: personal, environmental and behavioural. When taken together, they reflect an individual's expressed beliefs and feelings. Bandura stated that individuals adapt their behaviour according to their environment, which can provide insight into understanding an individual's behaviour towards using DHI. However, a comprehensive understanding of using DHI requires using multiple sources and factors due to its complexity (Keel et al. 2022). SCT might limit the knowledge, whereas a theory such as UTAUT adds more valuable elements, including social influence; thus, UTAUT could be better considered when designing this thesis (Venkatesh et al. 2003). The SCT can also be represented within the UTAUT as UTAUT encompasses many theories, including constructs similar to those in SCT. Therefore, when deciding on a more suitable theory, UTAUT could be considered due to its ability to provide an extensive understanding of both patients' and physiotherapists' experiences.

The UTAUT, developed by Venkatesh et al. in 2003, synthesises previous models of user acceptance to identify key determinants that influence technology acceptance and usage behaviour. Venkatesh et al. (2003) propose several factors, such as effort expectancy, performance expectancy, facilitating conditions, and social influences, as influential elements shaping an individual's intention to adopt a particular information technology. These elements which can reflect other theories such as TRA, SCT, and TAM (Venkatesh et al. 2003). Furthermore, the fundamental principle of UTAUT is the belief that the intention to use a particular information technology directly indicates its actual and regular use (Blut et al. 2022). Therefore, these factors not only affect the intention, but also govern the regular usage patterns of the individual. For these reasons, UTAUT can provide a clear factor that limits the acceptance and utilisation of any type of digital intervention (Venkatesh et al. 2003). It has been widely used in different fields and provides a clear understanding of factors that may also predict the acceptance of DHI's use in the future (Liu et al. 2014). Venkatesh et al. (2003) also acknowledge that cultural factors can significantly influence the use of technology. Therefore, the concept of culture is critical in the current context, as previously outlined in the scoping review. This aspect is further elaborated upon in subsequent sections.

The section below further clarifies the UTAUT constructs including the cultural factors involved in the theoretical framework of the current thesis (**Figure 3**). The UTAUT includes performance expectancy, effort expectancy, social influences, facilitating conditions, and based on the objective and context of the current study, cultural factors were also considered.

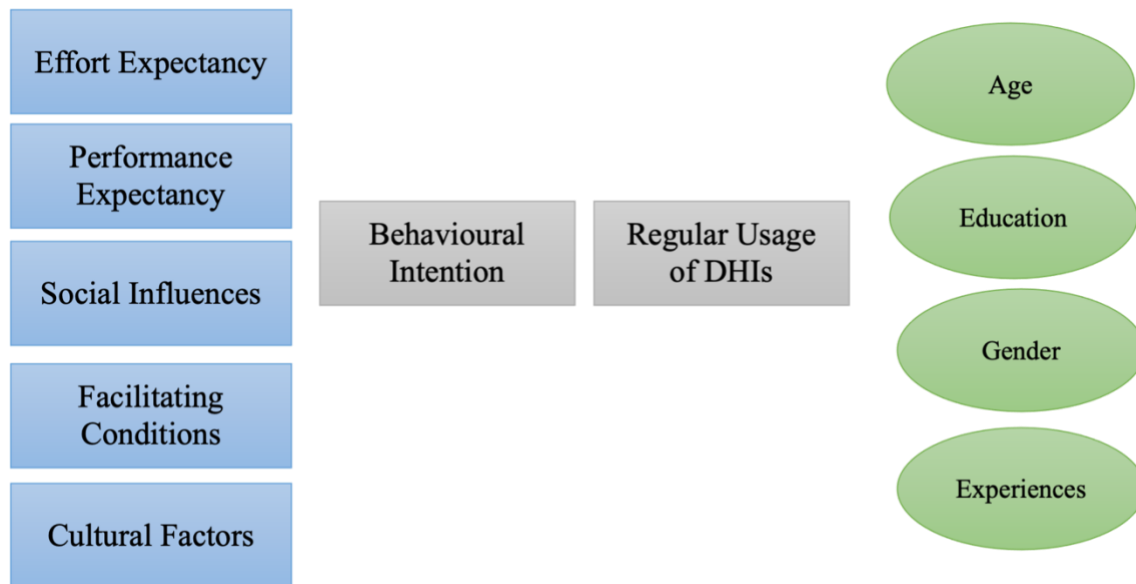


Figure 3: Theoretical model based on Unified Theory of Acceptance and Use of Technology (UTAUT).

Venkatesh et al. (2003) described the effort expectancy construct as end users' ease of using a new technology. In the context of UTAUT, effort expectancy guides the extent to which someone considers that a technology is easy to use and requires little effort (Venkatesh et al. 2003). In other words, it represents how simple a patient perceives the technology to be. A higher level of effort expectancy indicates that patients and physiotherapists believe that they can use a DHI without difficulty. Several studies have demonstrated the positive impact of effort expectancy and behavioural intention on the use of DHIs (Sun et al. 2013; Philippi et al. 2021; Yu et al. 2021). However, Liu et al. (2014) showed that effort expectancy did not affect physiotherapists' use of DHIs and demonstrated that this construct could initially impact the use of a particular technology, but have no impact later. Venkatesh et al. (2003) demonstrated that effort expectancy could affect behavioural intentions to use technology, but this impact depends on several factors such as age, gender and the level of education. Therefore, this construct can affect individual behaviours based on specific contexts which are investigated in the current study.

Performance expectancy refers to the perceived benefit of an intervention that leads to its use (Venkatesh et al. 2003). It is not limited to perceptions of the benefit alone, but also reflects an individual's desires and preferences. This concept in healthcare can be related to achieving the benefits of using DHIs for health outcomes and to healthcare providers' perceptions of work effectiveness and patient outcomes. Research evidence indicates a positive correlation between the impact of performance expectancy and the intention to use technologies (Sun et al. 2013). Performance expectancy is often the most influential factor determining behavioural intentions towards the use of technology (Philippi et al. 2021).

Social influence refers to an individual's perception that others believe they should use a specific technology (Venkatesh et al. 2003). It also reflects the extent of an individual's perception of pressure or encouragement from others in society to use new technologies, including DHIs. The impact of this construct can vary significantly across contexts and countries because it is often shaped by individuals' beliefs and the societal norms surrounding them. For instance, Liu et al. (2014) found that social influence did not affect physiotherapists' attitudes towards using DHIs in their settings. Liu et al. (2014) attributed this lack of influence to the individualistic nature of their Canadian society where decisions are less influenced by others than in collectivist societies. This aspect is further explored in the current study which focuses on Saudi Arabia, a country characterised as a collectivist society where individuals' actions and decisions are considerably influenced by others within their community.

Furthermore, Chau and Hu (2001) posited that there is no significant social influence on professionals' use of health technology and they attributed this lack of influence to the confidence many professionals have in their decision-making abilities and relative independence from others' opinions. However, this assertion may require further examination

when other factors such as age, gender and cultural context are considered. As Venkatesh's UTAUT model suggests, societal influences may significantly affect certain demographics such as women and older individuals in their acceptance of new technologies. Therefore, considering these variables within a specific cultural setting, such as Saudi Arabia, could provide valuable insight into how societal norms shape an individual's perception and acceptance of using DHIs. This understanding can then inform strategies to promote DHI adoption among various user groups.

Facilitating conditions refer to the circumstances which can either impede or enhance the sustained use of a specific technology. This concept, derived from the TPB, encompasses two sources: internal and external controls (Ajzen 1991). External control underscores an individual's belief that adequate resources are available for a behaviour to be executed, whereas internal control pertains to their confidence in their ability to perform that behaviour (Yang et al. 2009). In the current study, both of these aspects are examined, capturing patients' and physiotherapists' perspectives of the external and internal controls that are available and which could facilitate their use of DHIs. Most studies indicate that the availability of the necessary resources, coupled with individuals' ability to use technology, facilitates continued utilisation of technology. Therefore, this construct is relevant to the current research because it helps to explain the factors promoting sustained DHI usage.

- An extended UTAUT model proposed by Venkatesh et al. (2012) adds further constructs to the original model, namely, price value, hedonic motivation and habit. However, the current study did not consider these additional constructs for several reasons. First, price value was deemed not to be relevant in the current context because in the Saudi healthcare system, services are free of charge. A study conducted in Jordan

(another Arab country) did use the second UTAUT model, but Jordan's healthcare system differs from that of Saudi Arabia (Rasmi et al. 2020). In addition, the second UTAUT model included the construct hedonic motivation to reflect the enjoyment felt by individuals when using technology. This construct is not addressed in the current thesis because the first model already includes certain factors relating to motivation.

- Motivation is often explained in terms of self-determination theory and is enhanced when an individual achieves three basic psychological needs: autonomy, relatedness and competence (Deci and Ryan 2000). Autonomy refers to being fully involved and feeling in control of one's actions; relatedness involves feeling connected with others and valued by them; and competence pertains to having proficiency over one's activities or being skilled at what one does (Deci and Ryan 2000). These aspects can be reflected in the use of DHIs and influence behavioural intentions towards DHI usage. Furthermore, constructs such as social influence and facilitating conditions within the UTAUT could reflect the elements of relatedness and competence, respectively, making the separate inclusion of hedonic motivation unnecessary.
- Habit, in the second UTAUT model, refers to the formation or frequent performance of regular behaviours (Lally et al. 2010; Gardner et al 2022) and is acknowledged to be a useful construct for this study. The construct of specific habits is not included as a standalone concept in UTAUT Version 1, but the question regarding the regular use of technology was deemed appropriate for the current study because it provides information regarding regular use patterns observed with DHIs, thereby indicating the development of habitual behaviours among individuals. An indication of usage is important, as DHIs for physiotherapy have only relatively recently been implemented

in Saudi Arabia. The non-conscious processes associated with habit formation involving DHIs were not considered in the initial UTAUT model, but they are included in the second version (Venkatesh et al. 2012). For future research, it would be beneficial to include 'habit' and investigate these non-conscious processes that individuals may develop over time when using DHIs. With increased usage, users may gain more experience with these interventions, and their unconscious habits could significantly affect engagement patterns, therefore warranting further investigation.

Venkatesh et al. (2003) emphasised the importance of considering cultural factors in technology acceptance models. Thus, it was essential to include this element, given that the study is carried out in the context of Saudi Arabia, to allow for a more comprehensive and culturally sensitive analysis. Hofstede (1980) defines culture as distinct thought patterns which are evident in the significance individuals attribute to their actions. This definition can be linked to Islamic religious practices and beliefs whereby religious teachings guide specific behaviours and actions. These teachings form an integral part of a Muslim individual's thought processes, shaping how they perceive their world and influencing the meanings they attach to their behaviours, from daily activities such as prayer or fasting to broader life principles such as charity and honesty. The Islamic religion is a crucial component of its adherents' cultural identities; it shapes not only individual, but also collective behavioural patterns in Muslim-majority societies. Islamic beliefs significantly influence various aspects of Muslims' lives, including attitudes towards the use of technology. Islamic beliefs shape perceptions about different technologies' appropriateness, usefulness or acceptability, aligning with Straub et al.'s (2001) argument regarding the significant correlation between cultural beliefs and value resistance towards information technology use.

Culture significantly shapes individuals' beliefs and behaviours, as shown by numerous studies which highlight the influence of cultural and religious factors. For instance, it has been demonstrated that religious beliefs can sometimes lead to resistance towards using technology in healthcare. This perspective is supported by Ly et al. (2017) who note how religious and cultural norms can negatively influence patients' willingness to engage with technologically advanced medical practices such as telemedicine in Senegal. Furthermore, a perspective grounded in consideration of cultural factors is relevant not only to patients, but also to physiotherapists who incorporate DHI usage into their professional practices. Ehrari et al. (2022) emphasise that understanding these experiences and intentions to use such technologies is crucial, particularly when examining the cultural factors that influence acceptance and usage. Cultural factors can reflect physiotherapists' beliefs about the compatibility of DHI use with daily practice and, therefore, inform the exploration of culture-and work-related determinants and how physiotherapists perceive and experience integrating these technologies in their everyday practices. Meskó et al. (2017) stated that the successful integration of DHIs into regular healthcare services necessitates a cultural shift in the operation of these services. Understanding this transformation is critical to facilitate the effective use of DHIs in practice.

While Saudi Arabia, Senegal and many other Arab countries are Islamic societies, their socio-cultural contexts vary greatly. In particular, since Vision 2030 was launched in Saudi Arabia in 2016, significant transformations have occurred, which could affect behavioural patterns and attitudes differently to in other Islamic nations. These changes may alter how individuals perceive or interact with DHIs in the context of their self-management practices. Therefore, it is important to acknowledge these unique contextual elements when researching eHealth adoption in specific settings such as Saudi Arabia.

According to Venkatesh et al. (2003), factors such as age, gender, education and experience can affect an individual's use of specific technologies. For example, older people may experience difficulties using technology and, therefore, effort expectancy could be a significant factor for this population group. Similarly, women might be more influenced by their surroundings than men; hence, the construct of social influence could have a greater impact on women (Venkatesh et al. 2003). Education also plays a role, with well-educated individuals possibly finding it easier to use DHI, which could affect the facilitating conditions and effort expectancy constructs within the UTAUT model. Experience, whether positive or negative, will also shape an individual's perception of using particular technologies. All of these factors were considered in the current study to understand patients' and physiotherapists' experiences of DHI usage and the associated barriers or facilitators they encounter based on their perceptions of the constructs outlined above.

Furthermore, to understand the use of DHIs, behaviour intention and regular use of DHIs are addressed in the current thesis. As demonstrated by Venkatesh et al. (2003), behavioural intention refers to an individual's interest in using a particular technology, which can pave the way for actual usage and regular engagement with the technology. Regular use of technology can be referred to as the outcome of strong behavioural intentions. This likelihood to engage with these technologies on a regular basis may be influenced by factors identified in previous constructs or even other elements, which are explored in the current study. Moreover, expectations to utilise technology in the future can be regarded as projections of current behavioural intentions (Venktash et al. 2003). As such, present-day behavioural intentions have the potential to shape anticipations about future usage. Thus, understanding an individual's expectations for continued engagement provides insight into their existing behavioural

intentions. Therefore, all of these aspects of regular use and expectations for future use alongside underlying behaviour intention are considered in the current study.

3.6 Mixed methods: weaknesses/challenges

It could be argued that a mixed-method design is a hybrid method due to the unrelated paradigm for each design (Greene et al. 1989). As Creswell and Clark (2011) demonstrate, mixed methods designs have their limitations. First, it is time consuming, and second, the researcher needs to have expertise in both types of research (quantitative and qualitative). These challenges might be related to the design, convergent mixed methods, as it needs to be conducted at the same time; thus, the researcher needs to be skilled. In this study I decided to first conduct the quantitative phase and then, after analysing the data, conduct the qualitative phase. In addition, Creswell (2014) provides a strategy to overcome these difficulties, which includes preparation by the researcher and support by people who have skills in each design (Creswell 2014) so was appropriate as I am a doctoral student who is supported and provided with guidance by a supervisory team. The second challenge often related to the mixed method design is how the researcher determines the weight given to data collection and analysis for each design, the sequence of the design process and the integration of the result (Morgan 1998; Creswell et al. 2003). Practical guidelines are followed to address the potential issues that researchers may encounter, thus enhancing the design and implementation of a precise mixed-method approach.

The process of enquiry, as described by Dewey (1998), is like the methodology selected for this study. As Morgan (2014) states, the process begins with the action that then leads to the sequences. Based on the sequences, the researcher can evaluate the workability of the action being taken and alter it based on the researcher's warranted beliefs (Mertens 2015; Morgan 2014). Based on the pragmatic approach, the aim is to address specific issues or challenges by

seeking practical solutions through the investigation. This is like the aim of the current research, which is to investigate the issues related to the utilisation of DHIs and find more explanations that may provide possible actions that need to be taken to enhance the engagement with DHIs. In addition, utilising a mixed methods design could provide an integrated finding that might provide more useful knowledge that meets the expectations and gains the acceptance of both physiotherapists and patient.

3.7 Integration of mixed methods

The criticism for utilising mixed methods was provided by Smith (1983), who stated that it is difficult to integrate data that belongs to different philosophical worldviews. This debate might be confirmed if the transformative paradigm shifts from positivism to constructivism based on the utilisation of the methods. However, considering a pragmatism paradigm, which focuses on practical utility, will not create a conflicting paradigm. As the pragmatism paradigm considers both sets of data and aims to identify the factors that act as barriers and facilitators, focusing on this aspect can limit the conflict mentioned earlier. Other researchers emphasise the importance of mixed methods and can overcome this limitation by providing effective prior planning and considerations for each design (Bryman 2006; Creswell and Plano Clark 2018; Dawadi et al. 2021). Therefore, utilising and integrating mixed method study could provide strength for each method and overcome the weakness that might occur if each design is conducted alone.

The integration of the methods in mixed-methods design can occur at three different levels: design, methods, and reporting and interpretation (Tashakkori and Teddlie 2003). The results from the initial phase, which was quantitative, guided the sampling approach for the subsequent phase, which was qualitative. To illustrate, Feters et al. (2013) state that a sampling frame can be utilised to integrate the two methods. The sampling frame indicates that the sample for the qualitative methods can be recruited from the interested participants who have completed the quantitative methods; thus, the quantitative findings can be enhanced by utilising this framework. Furthermore, the integration of the methods also extends to the development of the interview schedule. To illustrate, the interview protocol was developed based on the findings of the surveys from both patients and physiotherapists so that more data can be identified. By utilising this approach, integration can occur at the interpretation and reporting level using

narrative methods (Creswell and Plano Clark 2018). The data integration can be seen in the discussion (**Chapter 8**), as the data integration for all phases occurred by comparing each finding. Furthermore, the research design employed is a sequential explanatory mixed methods approach (Creswell and Plano Clark 2018). Two separate phases mark this method: the first stage involves data collection and analysis through a survey, followed by a second stage focusing on qualitative data gathering and interpretation. This approach aimed to use qualitative findings to help explain and expand upon the quantitative research (Creswell and Plano Clark 2018).

In the first stage, quantitative data was collected through surveys for both MSK patients and physiotherapists and then analysed. The following chapter presents descriptive data for both participant groups, as suggested by Ivankova and Wingo (2018). Semi-structured interviews were conducted with patients and physiotherapists who used DHIs to gain deeper insight into the initial findings. The final steps involved integrating both sets of findings for interpretation; doing so allowed not only to understand what trends existed among participants' responses but also why such patterns occurred.

There are multiple approaches that researchers can follow to integrate the mixed methods design, namely, data transformation, joint display, and typologies (Bryman 2006). In addition, to understand complex social phenomena, action-oriented integration was suggested by Ivankova and Wingo (2018). The joint display is also considered one type of integration researchers can utilise. This type of integration is often utilised when the aim is to present both quantitative and qualitative findings together visually. I used this approach to provide a clear picture of the findings from each phase, and then conducting a narrative integration of findings from all phases. This approach helps to establish how the results interact and complement each

other. Therefore, the researcher can understand and follow the argument and the interpretation of the findings. Several steps have been taken to use the joint display approach, as McCrudden et al. (2019) recommended. These include looking at the theoretical framework, as the model undertaken in the current thesis (UTAUT), and when the researcher is looking at the conceptual framework, this can help interpret the result more effectively. I utilised two types of joint-display, table and mind map; these approaches provide a more transparent overview of the findings and make the integration process more manageable. In addition, it is essential to separate the findings involving data from both participants (MSK patients and physiotherapists), as each had a different understanding of the phenomena I was searching for. Therefore, by separating the data, I could recognise a clear overview of their views. Then, by providing data from each phase to understand the divergent and consistent findings, this process helps to provide an explicit narrative integration between the findings and provide more sense of the data.

While this approach can be a powerful tool for integrating and comparing qualitative and quantitative findings in mixed methods design, there is some potential disadvantage. To illustrate, Ivankova and Wingo (2018), stated that if the mixed methods are not designed carefully, utilising visual representations might lead to misinterpretations of the findings. In addition, simplifying the interpretation of the data by presenting the key findings leads to a loss of context and therefore threatens the research rigour (McCurdden et al. 2019). These limitations could impact the overall interpretation by omitting specific details which might have been significant. Therefore, careful planning and design of the display ensure that this approach is simple and accurate. In addition, this approach takes time, and therefore, the researcher needs to allocate this time to the timeline of their project. Careful planning for data

integration is crucial, as this process often requires a significant amount of time, sometimes even more than initially anticipated.

Existing typologies of mixed methods designs, such as those described by Creswell and Plano Clark (2018), can inadvertently lead researchers to focus more on fitting their study into these predefined structures rather than concentrating on the primary goal of using such integrations. In this thesis, integration effectively combines qualitative and quantitative data to provide comprehensive insights into my research questions. Utilising joint displays has been instrumental in clarifying consistent data points while also highlighting divergent ones for deeper interpretation. Rather than trying to fit my research idea into an existing design or restricting myself solely to the design type, I aimed to identify barriers and facilitators within a context that lacked foundational research. To achieve this objective, I first conducted a scoping review which provided an overview of DHI along with their potential barriers and facilitators; following that, a survey was utilised, which helped gather demographic information for MSK patients and physiotherapists while also providing insight about DHI usage within Saudi Arabia.

As recommended by Plano Clark and Sanders (2015) and McCurdden et al. (2019), I carefully considered which methods could best fit with answering research questions before beginning a primary investigation. This approach ensured alignment between methodology and objectives and optimal use of integration benefits. To mitigate potential disadvantages associated with joint displays, I adopted a narrative approach when integrating data from all phases of my research project. This method was particularly effective at drawing together findings from various stages into one unified narrative and providing a deeper understanding of the issues.

Furthermore, it allowed for detailed explanations regarding each data set as they relate to one another within a larger context.

3.8 Mixed methods design

The following table outlines the phased approach applied in the current study to understand and improve the use of DHI by physiotherapists and patients with MSK conditions. Each phase has specific aims, which are addressed by applying various methods such as questionnaires and interviews.

Table 6: Mixed methods design

Phase	Aim	Method
I	- To explore the demographic details of MSK patients and physiotherapists who utilise DHIs. - To identify the barriers and facilitators for physiotherapy and MSK patients in the use of DHIs.	Two separate questionnaires: one for patients and one for physiotherapists.
II	- To understand the barriers and facilitators to the recommendation and use of DHI by MSK physiotherapists. - To understand the barriers and facilitators to the acceptance and use of DHI by MSK patients. - To develop recommendations to assist and improve the use of DHI in the treatment of MSK conditions with the involvement of patients and physiotherapists.	Interviews: MSK patients and physiotherapists.

3.9 Summary

This chapter clearly provides the assumptions behind the researcher's paradigm and the rationale behind using a mixed methods study. The theoretical framework was emphasised for its pragmatic approach and survey instrument. Furthermore, the rationale for selecting mixed methods was also presented. The integration of mixed methods in this study was carefully considered and executed, following several steps and referring to best practice. The rationale for selecting various types of integration was to enhance the rigour of the research, thereby providing comprehensive and transparent findings. The next chapter discussed in detail the rationale of utilising the survey as data collection and other aspects of the quantitative phase in detail.

Chapter 4

Quantitative Method

Chapter4: Quantitative Method (Phase I)

(Survey)

A cross-sectional study to explore the barriers and facilitators experienced by the physiotherapists when using Digital Health Interventions as a self-management approach in Saudi Arabia

4.1 Introduction

This chapter aims to outline the method used in Phase I (the survey). However, it first briefly summarises the main findings from the scoping review in Chapter 2. This chapter's initial section summarises these critical insights, which helped to identify current knowledge gaps and set the groundwork for Phase I (survey). The next section provides information about both the mandatory requirement that physiotherapists in Saudi Arabia use DHIs and the types of DHIs available to them and to Saudi patients with MSKs. It also includes the potential aims and objectives of these DHIs. Then, the aims of Phase I are presented, followed by an outline of the process of developing the survey, including a further explanation of the UTAUT constructs, the processes undertaken to ensure validity and reliability, the recruitment strategies, the sample size requirements and, finally, the ethical considerations.

Data were gathered through a cross-sectional survey administered through the UTAUT model (Kelley et al. 2003), which explored many theories and factors for utilising DHIs (Venkatesh et al. 2003). Following data collection and analysis, a semi-structured interview schedule development was developed, as detailed in Chapter 6. As my study was conducted in Saudi Arabia, prevalence and risk factors related to MSK are presented. A limited amount of literature exists regarding prevalence, mostly focused on work factors as cross-sectional; therefore,

caution must be exercised to understand this indicator for comprehending MSK prevalence across populations in Saudi Arabia.

Recent research has primarily explored DHIs as an effective treatment option for MSK conditions (Hewitt et al. 2020; Valentijn et al. 2022). While content, design, and features of DHIs certainly play a large part in shaping patient attitudes towards using DHI (Berry et al. 2022), researchers argue that providing extensive information may overwhelm some users (Alego et al. 2019), and others argue that while providing a video feature increases both patients' and physiotherapists' satisfaction (Button et al. 2018), this view may not be comprehensive enough. Foster (2003) asserts that due to the complexity of chronic MSK pain, an integrated approach must be taken. The biopsychosocial model that Foster (2003) proposes recognises that health and illness are determined by various biological, psychological, and social influences rather than just biomedical ones alone. This concept fits my understanding of DHI use among patients with MSK disorders. Instead of solely considering the tool or pathology underlying their condition (the biomedical approach), I should also consider broader influences like healthcare providers' perspectives or environmental circumstances that might positively or negatively alter engagement levels. Successful treatment of chronic MSK pain requires more than simply treating physical symptoms alone; similarly, to ensure success with DHIs, we may need to consider different aspects affecting patient engagement.

4.2 Scoping review findings

The majority of the evidence related to experiences with DHI use has been gathered both through feasibility and pilot studies (Algeo et al. 2017; Bhattarai et al. 2020; Button et al. 2018; Bossen et al. 2016; Caiata Zufferey et al. 2009; Cronstrom et al. 2019; Geraghty et al. 2019; Ravn Jakobsen et al. 2018; Sparks et al. 2015; Mollard et al. 2018; Zuidema et al. 2019) and

through the use of short questionnaires following RCT trials with short six-month follow-ups (Bennell et al. 2017).

The initial scoping review indicates that more information is needed about the experiences of physiotherapists who have used DHIs and have integrated digital self-management in their clinical practice. Several theories and models that help to understand the factors that affect DHI acceptance and use have emerged, including the TAM, the theory of planned behaviour TPB, BCT, MM, and the UTAUT (Davis 1989; Ajzen 1985; Venkatesh et al. 2003). The most recent model is the UTUAT, which incorporates all the previous theories into one framework (Venkatesh et al. 2016). However, despite their popularity, these theories and models did not consider the effect of cultural factors, as previously discussed in **Chapter 2** and **Chapter 3**.

4.3 Digital Health Interventions in Saudi Arabia

In Saudi Arabia, the MOH has implemented a DHI infrastructure to support people using DHIs (MOH 2018). Saudi Arabia's mission and vision for 2030 stipulate that DHIs must be implemented in all healthcare systems (MOH 2020). In light of Vision 2030, which was implemented in 2016, the digitalisation of all healthcare services has been called for and is listed among the objectives to be achieved by 2030 (Vision '2030' 2016). In addition, the COVID-19 pandemic and the postponing of many healthcare services led to an acceleration in the process of digitalising medical records and the shift towards digital platforms due to the delivery of face-to-face healthcare services being impossible (Alghamdi et al. 2021).

The digital government strategy is updated annually, with the most recent update having been in 2023 (Digital Government Strategy 2023). The document highlights that in order to facilitate transformation and digitisation, it is crucial to reinforce institutional capacities and equip

healthcare organisations with the necessary skills and resources to manage DHI projects effectively within each institution (Digital Government Strategy 2023). Additionally, facilitating digital technologies based on assessing existing assets can help to identify where new or upgraded technology is needed for the effective use of DHIs. Numerous regulations and policies have been published for hospitals to address these developments. Organisations can implement regulations to enhance the transition towards digitisation and mandated DHI requirements. Outcomes are reported in the annual reports of healthcare professionals noting the achievements of key performance indicators (KPIs), as evidence of enhanced digitisation (MOH 2018; MOH 2022). While this could facilitate the use of DHIs among healthcare providers, there may also be negative effects. Therefore, institutions must create supportive environments at the policy level based on government-set strategies for successful implementation and utilisation (Digital Government Strategy 2023).

The Saudi MOH implemented DHI across multiple platforms and digital formats including mobile applications, telehealth, digital patient interactions and remote monitoring (Alghamdi et al. 2021). The app aims to empower users by equipping them with self-management tools for their health conditions (MOH 2018). One type of DHI, which has been implemented is **Sehhaty**, a mobile application that provides comprehensive healthcare services including physical activity tracking and patient education resources (MOH 2023). It is an innovative platform, which was developed by the Saudi MOH to enhance the quality of health among the population (MOH 2023). It is accessible in both Arabic and English and the login process for this app is linked to the national ID system, thereby suggesting high levels of privacy protection and safety for users. Such applications aim to empower patients by providing various healthcare services and updates regarding their overall health status. Additionally, each participating organisation offers personalised treatment based on individual patient conditions

and includes multimedia resources including videos, pictures and self-management content so that patients can interact with their healthcare providers.

Another platform is the web-based application **Annat**, which is accessible via the MOH portal (Alghamdi et al. 2021). It allows healthcare providers to directly interact with their patients by uploading videos and educational materials that facilitate patient care outside of traditional clinical settings. Furthermore, healthcare providers can maintain regular follow-ups using WhatsApp provided by the MOH through the MediaCenter (MOH 2020). This facilitates continuous support and monitoring of each patient's health condition (MOH 2020). In addition, another health application offers group services for individuals dealing with similar conditions through Telegram channels managed by physiotherapists who provide ongoing communication and support. Additional digital tools such as exercise routines tailored specifically for patients with MSK conditions were made available via QR codes linked directly with physiotherapists in each organisation. There are also a number of DHIs that are applicable within the organisation and linked to the Sehhaty under review (MOH 2022). These resources offer further personalisation in the provision of care while enhancing accessibility.

Numerous studies have been published on DHI for MSK conditions, such as the development of wearable sensors for rheumatoid arthritis (Raad et al. 2019) and web-based applications for self-management among nurses with lower back pain (Alduraywish et al. 2021). Additionally, research has investigated the effectiveness of mobile applications specifically designed to enhance physical activity through exercise and remote monitoring in patients with knee osteoarthritis in Saudi Arabia (Alasfour and Almarwani 2022). These include features such as step counting to promote physical activity and the use of wearable technology as a reminder for exercises or tracking individual performance (Almuwais and Alharbi 2022). Despite the

availability of various DHIs, such as **Sehhaty** and **Annat**, along with numerous other digital applications designed for patient use, most existing studies focus primarily on DHI utilisation among patients with hypertension or diabetes (Alanzi 2018; Alessa et al. 2021; Alzahrani et al. 2023). This highlights a gap in the literature regarding DHI usage among MSK patients in Saudi Arabia. Evidence of DHI use among MSK patients living in Saudi Arabia is limited. It is, therefore, critical to explore the factors that affect DHI effectiveness and use among patients with MSK conditions in Saudi Arabia. Whether clinical practitioners are prepared to utilise DHIs as a self-management tool has yet to be investigated in Saudi Arabia. In addition, no current research has investigated whether physiotherapists and MSK patients are willing to refer for or use DHI as a self-management tool in clinical practice. DHIs are not new in Saudi Arabia, although evidence indicates the existence of several barriers and facilitators to the utilisation of e-health; however, this evidence is limited to physicians or those utilising technology as an electronic recording of data (Alsulame et al. 2016; Al-Samarraie et al. 2020). Since the COVID-19 pandemic emerged in 2020, there has been rapid implementation of DHIs in the clinical practice of all healthcare providers, particularly physiotherapists.

This study explores the overall usage of DHI, behaviour intention, acceptance, and willingness of physiotherapists and MSK patients to use DHI to promote self-management for MSK. The quantitative findings from this study are used to formulate the next phase of the PhD and investigate patients' and physiotherapists' experiences to understand the barriers and facilitators adequately. Semi-structured interviews constitute this next phase and the findings from both phases are then utilised to provide recommendations for the future use of DHIs in Saudi Arabia.

4.4 Aim

4.4.1 Objectives

The objective of this study is:

To identify the experiences of using DHIs among MSK patients and physiotherapists in Saudi Arabia.

- a. To document the demographic characteristics of MSK patients and physiotherapists who are presently engaging with DHIs in Saudi Arabia.
- b. To identify factors that either facilitate or impede MSK physiotherapists to recommend and use DHI.
- c. To identify factors that either enable or hinder the use of DHIs by MSK patients.

4.5 Design and methods

This study is a mixed method, specifically an explanatory sequential mixed method (Creswell and Clark 2018; Teddlie and Tashakkori 2012). Based on the objective and the research question and by identifying the characteristics of both patients and physiotherapists who utilised DHI in Saudi Arabia, this can be done by adopting a cross-sectional design, and the benefit of utilising this method was mentioned in the previous chapter (Chapter 3).

4.5.1 Surveys

One data collection tool for the quantitative research method is a survey, also known as a self-report method, where individuals provide answers at a distance from the investigator. Neuman (2014) states that a high quality of questions is needed to provide a highly reliable and valid measure. In order to do that, I followed Leedy and Ormrod's (2015) guidelines to develop the survey. Also, considering Neuman's (2013) advice for developing a survey, the researcher avoided ambiguity by providing a straightforward question and maintaining the participants' perspectives by conducting a pilot phase.

Regarding the guidelines, first, the planning of the questionnaire was developed with explicit language, considering the aim of the research, understanding the population sample and how to distribute it, collecting the data, and finally generating a solid series of questions. These were all considered by the researcher adopting an online questionnaire, planning the questions with the researcher's supervisors. In addition, one of the requirements to develop a sufficient online questionnaire is to consider the time to complete the survey; as Nulty (2008) shows, online questionnaires are correlated with a lower response rate than paper questionnaires. Despite this finding and the fact that both methods were suggested in a previous scoping review, only an online approach was selected due to restrictions on paperwork imposed by COVID-19 safety measures. Therefore, the time required to complete the survey was maintained at approximately 10 minutes. Furthermore, the potential benefit of the online questionnaire is that participants can complete it at their convenience, with no missing data that can occur as with the paper questionnaire (Wright 2005).

4.5.2 Survey development

The current study aimed to gather the characteristics of the physiotherapists and MSK patients who utilised DHI in Saudi Arabia. The second aim was to understand barriers and facilitators to the recommendation and use of DHI by MSK physiotherapists, which will be based on UTAUT and cultural factors. This information will help to develop a proposed UTAUT model for using DHI in Saudi Arabia. Pre-testing the surveys by piloting was the next step to provide valuable content with simple language for the participants. The researcher developed two online questionnaires, one for patients and one for physiotherapists, based on a previous scoping review (e.g., the nature of DHI, nature of physiotherapist support, nature of the integration of DHIs and the availability of training), and the variables based on the UTAUT and cultural factors (5-point Likert scale) (Liu et al. 2014; Venkatesh et al. 2016). The questionnaire was translated from English to Arabic and back forward to English, based on the translation process's guidance (Beaton et al. 2000). The following steps were utilised to maintain the content validity of the questionnaire's language, namely, forward translation, independent bilingual translators, backward translation and finally piloting on the target population to enhance the translation method (section 4.6). The translation process was applied to the patient questionnaire. Participants were required to answer every question to standardise the results and fulfil the questionnaire's aim, which is to explore DHI usage by physiotherapists and MSK patients.

The questionnaire was grouped into three sections: (1) participant demographic data; (2) general DHI information and the number of months of DHI use; and (3) the Likert scale for statements reflecting the constructs of the UTAUT model adopted to understand the end-users intention to utilise a new digital intervention (Venkatesh et al. 2016; Liu et al. 2014). This can be seen in **Table 6** and Table 7, for each constructs, that demonstrates the statement related to

the constructs. The last section of the questionnaire contained four primary constructs explored: performance expectancy, effort expectancy, facilitator conditions, and social influences. Furthermore, the cultural construct was added to learn if there is a cultural impact to utilising DHI in Saudi Arabia (Alvesson and Karman 2007). Adding a cultural construct might be considered a critical step to extend the UTAUT to another context, which was also recommended by Venkatesh et al. (2003). Therefore, cultural factors were included in the questionnaire.

The primary objective of the current study was to collect and analyse data pertaining to the experiences of physiotherapists and patients with DHI in Saudi Arabia. To achieve this, a series of questions were formulated based on demographic information, which was informed by similar studies conducted in other countries and discussed with my supervisors. Age was considered an essential factor for understanding significant differences among those utilising or delivering DHI services. Additionally, I considered the experience levels of physiotherapists to be essential to determine if there is any insight between their years in practice and their use of DHIs.

The geographical locations where patients or physiotherapists reside also played a crucial role, mainly focusing on Makkah, one of Saudi Arabia's holy cities, where cultural and religious factors could potentially influence attitudes towards DHIs. Makkah is an iconic city that draws countless pilgrims daily for religious practices. Therefore, Makkah's hospitals cater to a diverse population from cities all across the globe; not only Saudis but individuals from Asia, Europe, South Africa, and more are present within this non-Saudi population, thus making consideration of such factors essential when providing healthcare needs and trends in this region.

The development of the survey was a collaborative process involving extensive discussions with my supervisors. Amendments were made based on these conversations to enhance the accuracy and relevance of the data collection tool. For instance, the decision was made to include lower levels of schooling in order to capture a broader spectrum of patient education levels rather than just bachelor's, master's, and PhD degrees. Furthermore, I modified specific questions for clarity, an example being the question "Have you received training in order to use digital health intervention?" which was changed into "Have you received any instructions about how to use DHI?" This adjustment aimed to distinguish between training that could be provided to the physiotherapists and straightforward advice and instruction that could be provided to the patients. I also simplified complex language that might have been difficult for patients' comprehension. Changes included reframing "I used DHI to become skilful at using it" into more straightforward phrasing: "Using a digital health intervention is useful in managing my health condition". Through discussions with my supervisors, these iterative improvements significantly strengthened my original draft by making it more precise and user-friendly, ultimately increasing its effectiveness as a research instrument.

The development of the survey for physiotherapists was also a collaborative process involving extensive discussions with my supervisors, leading to several amendments aimed at enhancing clarity and accuracy. For instance, I changed the question "Have you ever had training in order to use DHI in your practice?" as it could potentially be misinterpreted as asking whether they have used DHI in their practice, which is not within the inclusion criteria of my study. This study specifically required participants to have at least two months of experience using DHI. Therefore, I modified this question into a more precise form: "Have you received any formal training on how to use DHI during your professional practice?" This change ensured that my

questions accurately reflected the research parameters and reduced potential confusion among respondents.

Instructions were updated from the initial "sign to tick the box" format as I transitioned into an online format. Certain words were altered to be more appropriate for a professional audience of physiotherapists. For instance, statements like "I used DHI to engage with my colleagues actively" was changed to: "People who influence my practice/behaviour think that I should use DHI ". This revision aimed at better capturing social influence dynamics among peers within their department regarding DHI usage. Similarly, another statement – "I used DHI because it is seen as a positive development by my patients" – was rephrased into: "My patients think that I should use DHIs with them". This change sought insights into whether patient willingness influenced therapists' decision-making around implementing such interventions. These amendments not only improved precision but also enhanced validity through consultation and expert review and ensured the survey tool accurately reflected my research objectives while being user-friendly for respondents. At the end of the online survey, participants had the option to express interest and provide consent for future stages of my investigation. Recruitment into phase II (interviews) began after analysing the data of the current phase; the invitations were extended only to individuals who expressed willingness and provided their information. This ensured that only committed participants continued further with subsequent stages.

4.5.3 Explanation of each UTAUT constructs and cultural factors

This section describes each construct of the UTAUT and the statements that were considered in the survey to capture the perceptions of patients and physiotherapists regarding the use of DHIs. The respondents were asked to indicate their agreement or disagreement with the UTAUT statements.

Table 7: Constructs of the Unified Theory of Acceptance and Use of Technology (physiotherapists)

Constructs	Survey questions in the Likert Scale (Physiotherapists)				
Effort Expectancy	I found DHI easy to learn about	I found using DHI easy to use	Using the DHIs makes it easier to provide education/therapy/advice to my patients	I believe that it is easy for patients to use DHI and to perform what I want them to do	
Performance Expectancy	Using DHI can increase my productivity in my work	The quality of the service that I provided to my patient can increase when I am using DHIs	Using DHI can enhance the quality and quantity of the outcome of my patients	Using DHI is compatible with my patients needs	
Social Influences	My patients think that I should use DHI with them	Physiotherapists in my organisation who use the DHIs have more prestige than others	People who influence my practice/behaviour think that I should use DHI	The use of DHI could potentially strengthen my relationship with my patients	
Facilitating Conditions	I have the resources necessary to use the DHIs.	I have the skill to use DHI in my work	I have the knowledge necessary to use the DHIs.	I found someone available to help when I am experiencing any difficulties with DHIs	My organisation has supported the use of DHIs
Cultural Factors	Using DHI is compatible with my religious and cultural values	Using DHI fits in with my daily life practice	Using DHI is compatible with my needs.		
Using DHI	I intend to use the DHI	I am using DHI regularly	I expected to keep using DHI		

Table 8: Constructs of the Unified Theory of Acceptance and Use of Technology (MSK patients)

Constructs	Survey questions in the Likert Scale (Patients)				
Effort Expectancy	Digital health intervention is easy to use	Using digital health intervention makes it easier to receive therapy from the physiotherapist	I believe that it is easy to do what a physiotherapist wants me to do when using digital health intervention	I found it easy to modify exercises and understand the information when using digital health intervention	
Performance Expectancy	Using digital health intervention is helpful in achieving my treatment goals	Using digital health intervention is useful in managing my health condition	Using digital health interventions enhances the effectiveness of the treatment that is provided by the physiotherapist	Using digital health intervention enhances my awareness of my health condition	Using digital health intervention is appropriate with my needs
Social Influences	My family/friends believe that I should use digital health intervention	My physiotherapist believes that I should use a digital health intervention	People around me who use digital health intervention have more prestige than those who do not	People who influence my practice/behaviour think that I should use digital health intervention	Using a digital health intervention would enhance the relationship with a physiotherapist
Facilitating Conditions	I have the resources necessary to use digital health intervention	I found someone available to help me when I am experiencing any difficulties with digital health intervention	I have the knowledge to use a digital health intervention		I have the skill to use digital health intervention
Cultural Factors	Using digital health interventions are compatible with the Islamic tradition	Using digital health interventions are compatible with Saudi customs and values	I found the use of digital health interventions fits into my daily life.		
Using DHI	I intend to use digital health interventions	I am using DHI regularly	I expected to keep using digital health intervention technique		

For each construct, see the methodology for a detailed description.

The first construct was the effort expectancy of physiotherapists (**Table 6**) and patients with MSK conditions (**Table 7**). Effort expectancy refers to perceptions regarding the ease of use associated with DHIs and this construct was represented in several statements obtained from Liu et al. (2014) and Venkatesh et al. (2003). The first statement was intended to determine and understand the respondents' perceptions regarding whether they found DHIs straightforward and uncomplicated to use (Sun et al. 2013; Philippi et al. 2021). The second statement was intended to determine whether or not the respondents perceived DHIs to be user friendly and simple to deal with. These statements capture how DHIs simplify the work of physiotherapists in terms of delivering healthcare services and providing education and advice to their patients (Liu et al. 2014). They also advance our understanding of these practitioners' beliefs regarding how effortlessly they believe patients can interact with these tools to achieve the desired outcomes.

The second construct relates to performance expectancy and was explored for both physiotherapists and MSK patients and their perceptions of using the DHI. For physiotherapists (**Table 6**), these involved exploring their beliefs regarding how DHIs enhance work productivity and the overall quality of the treatment provided by DHIs (Liu et al. 2014). The physiotherapists were also asked whether these DHIs improved their patients' health condition outcomes. For the MSK patients (**Table 7**), several statements were adopted to determine their perceptions of the benefits and usefulness of such technology, as demonstrated by Venkatesh et al. (2003), and whether DHIs improved their awareness of their conditions (Zufferey et al. 2009). Both MSK patients and physiotherapists considered compatibility with needs, either from the healthcare provider's perspective of what fits well with patient requirements or from the individual patient's viewpoint regarding whether their healthcare needs are met. Murray et

al. (2016) emphasised the importance of considering the compatibility of the DHI with patients' needs to enhance its uptake. It is also important for the MOH to understand patients' needs to enhance and improve the DHI in Saudi Arabia (MOH 2018).

The social influence construct can provide insight into individuals' beliefs about the social recognition attached to the use of technology within their community (Venkatesh et al. 2003). Such influence among physiotherapists can be determined based on MSK patients' acceptance of DHIs, the use of DHIs by colleagues and the pressure exerted to use DHIs in professional practice (Liu et al. 2014). It can also clarify the influence of family, friends or physiotherapists on MSK patients' beliefs and consequent improvements in DHI use (Venkatesh et al. 2003). The influence of others can be linked to prestige and can function as a formative influence on user behaviour (Venkatesh et al. 2003). As Venkatesh et al. (2003) emphasised, if an individual notices that technology use is associated with prestige within their social circle because of the advanced functionalities of the technology, the end user may be convinced to adopt this innovation. Furthermore, the social influence construct can capture participants' perspectives regarding the potential impact of the relationship between patients and physiotherapists on the use of DHIs, as demonstrated by previous studies (Kristjansdottir et al. 2011; Liu et al. 2014; Leese et al. 2018). Therefore, prestige and relationships between patients and physiotherapists were considered in the current study to understand the effect of social influence factors on the individual use of DHIs.

The availability of resources and supportive environments represent facilitating conditions, which was another construct considered in the current study. For patients, facilitating conditions are determined by having the necessary resources to use DHIs. External support refers to the availability of assistance when facing difficulties, whereas adequate knowledge

and skills to use these tools effectively refers to the internal ability of individuals to use a particular technology (Venkatesh et al. 2003; Parker et al. 2013; Button et al. 2018; Kloek et al. 2020). Similarly, physiotherapists' perceptions of facilitating conditions include not only resource accessibility but also skillset adequacy for effectively incorporating this into their work (Liu et al. 2014). Another important aspect was their perception of receiving support when encountering challenges with these tools and organisational support for DHI usage within practice settings (Liu et al. 2014). All of these factors can provide insight into the organisation's support for their physiotherapists, as previously acknowledged, which affects physiotherapists' attitudes towards the DHI (Button et al. 2018).

Cultural factors were an additional construct included in the analysis alongside traditional UTAUT constructs and further details regarding this are provided in **Chapter 3**. The current study refers to perceptions about the cultural compatibility of DHIs and their alignment with religious beliefs. It can capture aspects of cultural compatibility between DHIs and local customs or traditions. Another consideration relates to fitting DHI usage into daily life for patients to capture the impact of cultural context for physiotherapists who incorporate DHI usage into their professional practice (Ehrari et al. 2022). Further exploration regarding the use of DHIs that are compatible with physiotherapists' needs is required to understand cultural perspectives for the integration of DHIs into daily life practice, as discussed by Meskó et al. (2017).

Finally, to explore the overall use of DHIs, three other aspects were examined in this study: behavioural intention, the regular use of DHIs and expectations to use these technologies (see **Chapter 3** for further details). There was a need to understand the expectations of both patients and physiotherapists with regards to using these interventions in the future. This understanding

can contribute to the development of recommendations based on these experiences, aligning with the research objectives of the current thesis. As Venkatesh et al. (2003) revealed, exploring these usage patterns can ensure a better understanding of the factors that facilitate sustained use and assist in the effective long-term use of a particular technology.

4.5.4 Validity and reliability

Validity and reliability are two fundamental research elements, particularly measurement instruments. Validity refers to how well a tool accurately assesses the specific element that are designing to measure it (Carmines and Zeller 1979). When having high validity, it accurately reflects the concept or the construct it was designed to measure. In addition, reliability refers to the consistency or repeatability of measurement from an instrument over time (Nunnally and Bernstein 1994). A reliable measurement provides stable responses across repeated testing. In this study, several steps were taken to ensure both these aspects through careful design choices like using the Likert scale. The Likert scale has proven to be a valid and reliable method for understanding attitudes and opinions among participants (Sullivan and Artino 2013). This can range from two points of agreement, such as "agree" or "disagree". However, some researchers argue that this approach may not capture the full spectrum of perceptions and could bias findings by providing only two options. In order to avoid potential biases in the current study, I utilised a 5-point Likert scale (totally agree, agree, neutral, disagree, or totally disagree). Participants can express their thoughts along a spectrum rather than being forced into two choices, providing more nuanced responses (Joshi et al. 2015). This approach offers participants a variety of response options, which helps ensure unbiased results while maintaining the accuracy and consistency of the Likert scale.

To further enhance accuracy in capturing technology perceptions and views, I incorporated questions based on UTAUT, an established model with validated measures (Venkatesh et al.

2003; Liu et al. 2014). The expert review and pilot testing (Section 4.6) were also conducted for content revision, which helped improve the overall survey design, ensuring it accurately measured the intended variables. Reliability, which refers to consistency over time, is typically assessed by administering the same survey to the same group at different times. In this study, however, repeated measures were unnecessary since DHI usage was captured at one point. Where studies aim to assess effectiveness pre-post intervention, assessing test-retest reliability would be crucial before using such surveys.

4.5.5 Sample population/ recruitment

Purposive sampling was used to select the sample that best represents the aim and objective of the project. Six government hospitals in Saudi Arabia were selected: King Faisal Hospital (Taif), King Abdullah Medical City, King Abdul-Aziz Hospital, Al-Noor Hospital, Heraa General Hospital, and King Faisal Hospital (Makkah); and one private hospital, Sultan Bin Abdulaziz Humanitarian City (SBAHC). After receiving ethical approval from the Cardiff University School of Healthcare Sciences Ethics Committee and the MOH and private hospital, invitation letters were sent to all participating hospital physiotherapists using the WhatsApp application's working mobile number via physiotherapist department heads. The invitation also was sent to the Saudi Physical Therapy Association (SPTA) to recruit physiotherapists meeting the inclusion criteria. The researcher provided an information sheet to the physiotherapists interested in the study, asking those individuals to confirm their study participation intent within 72 hours. All interested physiotherapists were then sent a message with a consent form and an online questionnaire link via the WhatsApp application's working mobile number.

Patient recruitment was conducted via the researcher and the physiotherapists. The researcher contacted each hospital's physiotherapy department head to recruit patients by promoting the

letter via flyers and posters in the physiotherapy department corridors, waiting rooms, and reception areas. The physiotherapist discussed the study's availability with their patients. Patients interested in the study scanned a QR code to receive the patient information sheet and a QR code to receive the consent form and questionnaire (Appendix XIII).

4.5.5.1 Inclusion and exclusion criteria

1. Physiotherapist

- ❖ At least two months of experience with using any DHI for patients with MSK disorders. This timeframe is based on previous research indicating that usage rates often decrease after this period (Button et al. 2018; Kloeck et al. 2020).
- ❖ Physiotherapists working in both private and government hospitals in Makkah or Taif city.

2. Patients

- ❖ Existing MSK condition.
- ❖ Any experience with the use of DHI, this to allow for a wide range of experiences and perspectives, which can provide more comprehensive insights into the use of DHI among MSK.
- ❖ Access to computer.

4.5.6 Sample size

The sample size of Phase 1 was based on the previous studies, Liu et al. (2014), and the number of explanatory variables. Peduzzi et al. (1996) stated that ten times the number of explanatory variables is needed in the theoretical model to be considered an essential sample size. Based

on the UTAUT, four explanatory variables will be used to predict the utilisation of DHIs and a cultural variable ($5 \times 10 = 50$) to expect the event per variable (EPV). In Liu et al. (2014), EPV was 68.24; therefore, the expected estimated sample size is 74 for each patient and physiotherapist. A pilot study was conducted for one patient and one physiotherapist; however, their data were not included in the data analysis.

4.5.7 Ethical considerations

This study received ethical approval from the Ethics Committee at the school of Healthcare Sciences, Cardiff University (Appendix III, ethical approval (1)). Further approvals were received from the MOH Ethics Committee in Saudi Arabia (Appendix IV, ethical approval (2)). Finally, ethical approval was received from the SBAHC (Appendix V, ethical approval (3)). All ethical considerations were considered during the current study's recruitment, data collection, and analysis stages. An information sheet was developed and approved, and the language in the information sheet was made with simple words to ensure that the nature of the study was precise. Information sheets highlighted the right to discontinue their participation in the study at any moment without providing a reason and without any impact on the relationship between the researcher and the withdrawing participant and no participants were forced to participate in the study. Moreover, details about how their answer will be used and that all their information will be kept confidential and anonymous were written in the information sheets for the physiotherapists (Appendix VIII) and for the MSK patients (Appendix XIV). Before initiating the survey, informed consent was obtained from all participants, physiotherapists (Appendix VI) and patients (Appendix XVI), this form used in this study was the same as the one available online. The researcher collected all the data for this study phase, and only information relevant to the study was collected. All consent forms and data were kept confidential and stored on a password-protected online drive at Cardiff University. After the

participants signed the consent forms, their names were associated with nonidentifying codes to secure their data and maintain anonymity (Drummond and Campling 2013).

Informed consent was obtained from all participants. A PDF form, which included the information sheet and consent form, was provided to the physiotherapists. They signed their paper forms after reading the information sheet and agreeing to participate in this study. These files were saved in my records under non-identifying codes to ensure data security and maintain participant anonymity. For patient recruitment via QR code scanning, I streamlined the process by providing all necessary documents online: the information sheet, a consent form, and a survey. This made it easier for patients to access the information sheet before initiating participation. The head of the department of physiotherapists for each hospital informed physiotherapists about the study and provided the inclusion and exclusion criteria form. Within the form, there is a QR code that patients who meet the criteria can scan the information sheet, and if they agree to take part, provide their informed consent. This was ensured by making it a mandatory field within the online forms; no one could proceed with the survey without filling out this section first. Personal data, such as mobile number/email correspondence, were kept in a data storage file on an online Cardiff drive. Although the study data will not be shared with anyone, the study results might be published or presented at conferences, and this was written in the information sheet to make it clearer for the participants. The consent of the agreed participants was declared to the participants, and consent for sharing the study results was included in the consent form. To maintain the research's integrity, personal and anonymised data will be retained based on the Research Project Conduct and the University's Research Records Retention Schedule and kept on a protected university server and destroyed after 15 years.

Due to the online nature of this project, no physical contact with the participants occurred, negating any possible transmission of COVID-19, as the study was conducted during the restriction period. Therefore, there were limited risks attached to this data collection process. Eye strain might occur due to a digital device (Coles-Brennan et al. 2019), but this is unlikely because of the relatively short duration of filling out the questionnaire. However, I advised the participant in the information sheet to break from the digital device if needed (Coles-Brennan 2019). Information was provided regarding the patient's usual care, and this study was not influencing the patient's usual care, and no changes occurred during and after the end of the study. Finally, this study's results will be shared with participants who wish to understand the factors that might impact their acceptance and interactions with technology in clinical practice to enhance the quality of healthcare services.

4.6 Pilot study

The pilot study was conducted for two participants, one physiotherapist and one patient with MSK conditions. Leon et al. (2011) stated that a pilot study aims more at testing procedures than generating statistically significant data. Therefore, this pilot study effectively served its purpose even with a smaller sample size. The goal was to identify the steps and procedures for utilising an online method and to ensure clarity in the understanding of survey questions among participants. This approach aligns with the perspective of Leon et al. (2011), who revealed that the primary aim of a pilot study is to refine methodologies rather than test hypotheses. Therefore, even with just two participants in this pilot phase, invaluable insights were gained into the testing procedure and methodology refinement. Furthermore, during this phase, it became evident that adjustments were needed in the recruitment approach due to cultural context. Initially, email was chosen as a mode of communication for survey distribution; however, participants' feedback indicated that WhatsApp is more commonly used in Saudi

Arabia. Therefore, based on these insights from the small-scale pilot test, modifications were made by incorporating WhatsApp alongside email, enhancing accessibility and participation potential when moving into the data collection stage.

The rationale was to understand if the content and language of the questionnaire were appropriate to enhance the face validity and content of the questionnaires (Portney and Watkins 2013). In developing the survey tool for this study, I engaged in several rounds of discussion with my supervisory team to ensure its validity and relevance to my research objectives, such as understanding the demographic data of both patients and physiotherapists, which can be found by asking a general demographic question related to the participants' ages, education. These dialogues played a crucial role in shaping both the content and structure of the current survey. For instance, overall, there was a positive comment from the patients and physiotherapists. From the feedback, some questions were reordered to make them clearer. For example, the question related to integrating a DHI during the treatment had been followed by the best strategy for integrating DHI from the physiotherapists' perspective. This question was reordered later in the questionnaire to obtain a clearer perception from the physiotherapists.

In addition, the technical organisation of some of the questions was improved. For instance, one question asked physiotherapists if they had used outcome measures with their patients. However, the following questions asked for more details concerning the outcome measures, even if the physiotherapist had said they did not use them. After the changes, the follow-up questions were asked only of those participants who answered that they had used outcome measures. Further, the patients provided additional types of MSK conditions outside the provided options; thus, the researcher provided other options to specify what types of conditions the patients suffered from. The scale option in the fourth section of the questionnaire

was rearranged similarly. For example, it began with total disagreement for the first part of the UTAUT, while the next questions, regarding the intention and use of the DHIs, began with agreement options. As this arrangement might confuse patients and physiotherapists, the questions were rearranged. Furthermore, the possible answer options for participant training questions were clarified. To illustrate, the questions were 'Have you ever had the training to use DHI in your practice?' and 'Have you ever had training by your organisation to use DHI in your practice?' The answer options related to the types of DHI needed to be clarified and more options needed to be added, such as mHealth or eHealth with regular sessions.

Rindfuss et al. (2015) stated that a questionnaire's response rate might reduce if it required a long time to complete, and the quality of a study's findings could be influenced negatively based on a long-estimated time to complete its questionnaire. Therefore, an estimated average time could be given to enhance the questionnaire's response rate. Thus, the researcher monitored each participant's time to complete the questionnaire. For physiotherapists, the estimated time was 6 to 10 minutes, and for patients, the estimated time was 15 to 23 minutes. The estimated time for completing both questionnaires will be provided after the data collection period based on the pilot study completed by all participants. The questionnaire's final design was completed after reviewing the pilot study's comments and agreed between the researcher and supervisory team. The Arabic questionnaire was translated into English after collecting the data, and the translation will be based on guidance during the translation process (Beaton et al. 2000). This guidance requires forward translation, and backward translation to enhance the translation process for the final data-collection period. The content validity of the questionnaire could be maintained by following the guidelines for the translation process.

4.7 Data analysis

The data analysis for the questionnaire was conducted using Statistical Package for Social Sciences version 21.0 for Windows (SPSS Inc., Chicago, IL, USA) by using a descriptive statistical analysis for demographic data and percentage, frequency (age, gender, level of education, and experiences) and the usage of DHIs. Descriptive statistics were used to present participants' characteristics and patterns of answers to the different survey scales. Both categorical variables and grouped numerical variables, such as age ranges and years of experience, were presented using frequencies and percentages (Kaliyadan and Kulkarni 2019). This approach provides a clear overview of how respondents were distributed across these categories. The Likert scale was used for an analysis based on the construct of the UTAUT as a percentage. The level of measurement for Likert scales is ordinal (Blaikie 2003). Based on Jamieson (2004), descriptive analysis can be used for the Likert scale, as percentages allow an understanding of how respondents are distributed across all categories. This analysis is different from using mean or median, as using the Likert scale gives a middle value. Therefore, using percentages allows the researcher and reader to understand the participant's view of each construct, enhancing the data analysis. There was no missing data as this was organised in the questionnaire, and the participants had to answer with a required option.

Chapter 5

Quantitative Findings

Chapter 5: Quantitative Findings (Survey)

Survey Findings (Phase I)

5. Result (Quantitative phase)

This chapter is the second phase of the thesis and will present the results from survey data collected from MSK patients and physiotherapists utilising DHI in Saudi Arabia. I will begin by providing general demographic data for participants, followed by an overview of training availability, methods offered to patients, and overall agreement levels using a Likert scale under the UTAUT framework with consideration for cultural factors. Furthermore, the behaviour intention levels in terms of percentage distribution across Likert scale categories and regular usage levels and expectations. Finally, I will discuss these findings in depth while establishing a rationale for the subsequent qualitative phase of this thesis.

5.1 Results

One hundred forty-three respondents completed the questionnaire; 76 physiotherapists who treated patients with MSKs, and 67 patients with MSK conditions; both physiotherapists and MSK patients were from Jeddah, Makkah, Taif, and Riyadh in Saudi Arabia. Questionnaire distribution and completion took place between April 2021 and July 2021. The following sections will describe the demographic data for each group and general information regarding DHIs in Saudi Arabia and provide an overview of the data analysis for the UTAUT.

5.1.1 Demographic data

The following table provides participant characteristics for two study populations (physiotherapists and MSK patients).

Table 9: Physiotherapists' characteristics in the two study populations

Parameter	Category	Frequency	Percentage
<i>Physiotherapists (n=76)</i>			
Gender	Male	41	53.9
	Female	35	46.1
Age category (years)	25-35	66	86.8
	36-45	10	13.2
Type of employment	Full time	75	98.7
	Part time	1	1.3
Healthcare setting	Public hospital	72	94.7
	Private clinic	1	1.3
	Other	3	3.9
City	Makkah	50	65.8
	Jeddah	5	6.6
	Taif	19	25.0
	Other	2	2.6
Education	Bachelor's	62	81.6
	Master's	9	11.8
	Other	5	6.6
Years of practice	0-5	28	36.8
	5-9	32	42.1
	10-20	14	18.4
	>20	2	2.6

As shown in **Table 8**, the age distribution showed that most of the respondents (86.2%) were aged 25 to 35 years and the majority were physiotherapists with 5–9 years or less than five years of experience. Regarding the level of education, most of the physiotherapists (82%) held a bachelor's degree. In addition, most of the respondents worked full-time and the public hospital is the most common site of work (95% and 98%, respectively).

Table 1011: Patients' characteristics in the two study populations

Parameter	Category	Frequency	Percentage
<i>Patients (n=67)</i>			
Gender	Male	10	14.9
	Female	57	85.1
Age (years)	18-25	8	11.9
	26-35	17	25.4
	36-45	18	26.9
	46-55	15	22.4
	≥ 56	9	13.4
Education	Primary	6	9.0
	Intermediate	7	10.4
	High school	12	17.9
	Bachelor's	35	52.2
	Master's	4	6.0
	PhD	1	1.5
	Other	2	3.0
Condition	Arthritis	17	25.4
	Low back pain	31	46.3
	Osteoarthritis	4	6.0
	Other	15	22.4
Time from diagnosis	0-3 months	10	14.9
	4-6 months	9	13.4
	7-12 months	8	11.9
	≥ 12 months	40	59.7
City	Makkah	61	91.0
	Taif	4	6.0
	Jeddah	1	1.5
	Riyadh	1	1.5

Table 9 shows that for patients, the difference between genders was noticeable as only 15% of the patient sample were male, whereas 85% of the respondents were female. In addition, approximately two-thirds of the patients were educated with a bachelor's degree or higher, and most of the respondents were from Makkah City (91%). Furthermore, most of the respondents suffered from LBP (46.3%), followed by arthritis (25.4%), with most having been diagnosed for more than one year (59.6%).

5.1.2 General data for the Digital Health Intervention

Table 10 provides a general overview of the DHI in terms of training, advice, strategies for implementing a DHI, mode of DHI delivery, months of DHI use, and general outcome measures that physiotherapists used in their practice.

Table 12: General information on Digital Health Interventions among physiotherapists.

Parameter	Category	Frequency	Percentage
<i>Physiotherapists (n=76)</i>			
Training for use of DHI	Yes	14	18.4
	No	56	73.7
	I do not know	6	7.9
Months of DHI use	Up to 2 months	42	55.3
	3-4 months	11	14.5
	5-7 months	8	10.5
	8-12 months	9	11.8
	>1 year	6	7.9
Delivery option for DHI	Web-based	16	21.1
	Smartphone-based	51	67.1
	Telehealth/telerehabilitation	38	50.0
	e-health	16	21.1
	Wearable technology	3	3.9
Strategy of the implementation	Blended approach	7	9.2
	Replacement to the session	15	19.7
	Follow up tool.	29	38.2
	Additional tool	13	17.1
	All	12	15.8
Using of outcome measure	Yes	12	15.8
	No	47	61.8
	I do not know	17	22.4

DHI – digital health intervention, **PT**– physiotherapist

The findings from **Table 10** indicate that most of the physiotherapists did not receive training before utilising a DHI (73.7%) and that more than half of the physiotherapists had experience with it for up to two months (55%). Regarding the mode of DHI delivery, most of physiotherapists reported that smartphone-based was the most common mode for delivering DHIs. Furthermore, the most common strategy for implementing DHIs was as a follow-up tool

(38%) and the majority of physiotherapists (61.8%) utilised an outcome measure in their usage of these DHIs.

Table 13: General information on Digital Health Interventions among MSK patients.

Parameter	Category	Frequency	Percentage
<i>Patients n (=67)</i>			
Advice on using DHI	Yes	14	20.9
	No	48	71.6
	I do not know	5	7.5
Strategy of using DHI	Educational tool	21	31.3
	Replacement to the session	11	16.4
	Follow up tool	15	22.4
	Blended approach	11	16.4
	All	9	13.4
Mode of DHI delivery	Smartphone-based	34	50.7
	Web-based	16	23.9
	Web/smartphone based	6	8.9
	Web-based/PT support	3	4.5
	Web-based/session with PT	24	35.8
	All	9	13.4
Months of DHI use	0-2 months	44	65.7
	3-4 months	13	19.5
	5-7 months	5	7.4
	8-12 months	0	0
	>1 year	5	7.4

DHI – digital health intervention

Table 11 reveals patient information associated with DHI. As with the physiotherapists, most patients did not receive any advice before using a DHI (71.6%). Most MSK patients (65.7%) reported using DHI for a short duration of 0-2 months, with half utilising smartphone-based apps. The primary mode of delivery was as an educational tool (31.3%).

5.1.2 Understanding the utilisation of Digital Health Interventions among physiotherapists: Insight from UTAUT factors.

In this section, the aim is to provide an understanding of physiotherapists' perspectives on the use of DHI in Saudi Arabia. The understanding of the factors that limit or facilitate the use of DHI is based on the UTAUT model along with the cultural factors. **Figure 4** provides an overview of physiotherapists' perception of using DHI based on effort expectancy, **Figure 5** is based on performance expectancy, **Figure 6** is based on social influences, **Figure 7** is based on facilitating conditions, and **Figure 8** is based on cultural Factors. Figure 9 provides the overall view of regular usage and behavioural intention to use DHIs among physiotherapists. All these figures demonstrate percentages of agreement or disagreement with the UTAUT construct.

Figure 4: Effort expectancy of Digital Health Intervention among physiotherapists (n=76).

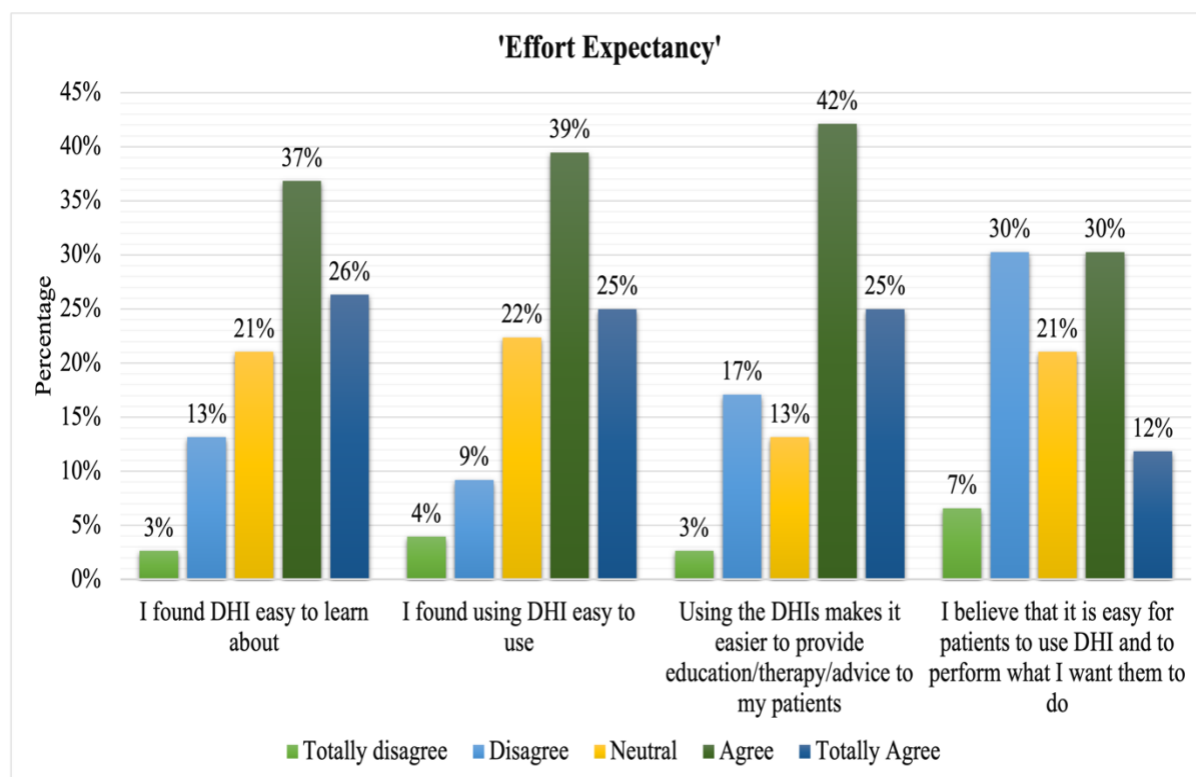


Figure 4 clearly demonstrates that overall, physiotherapists reported positive feelings towards DHI use. For example, on the statement 'I found DHI easy to learn about', 63% agreed, and another 25% totally agreed; only a small proportion (4%) expressed total disagreement. Furthermore, the majority found DHIs to be easy to use (64%) and to provide therapy to and educate their patients with (67%). However, views regarding the ease of use for patients were somewhat mixed; whilst 42% of physiotherapists agreed that DHIs were easy for patients to use, 37% disagreed, thereby demonstrating that opinion was more divided compared to other statements.

Figure 5: Performance expectancy of of Digital Health Intervention among physiotherapists (n=76)

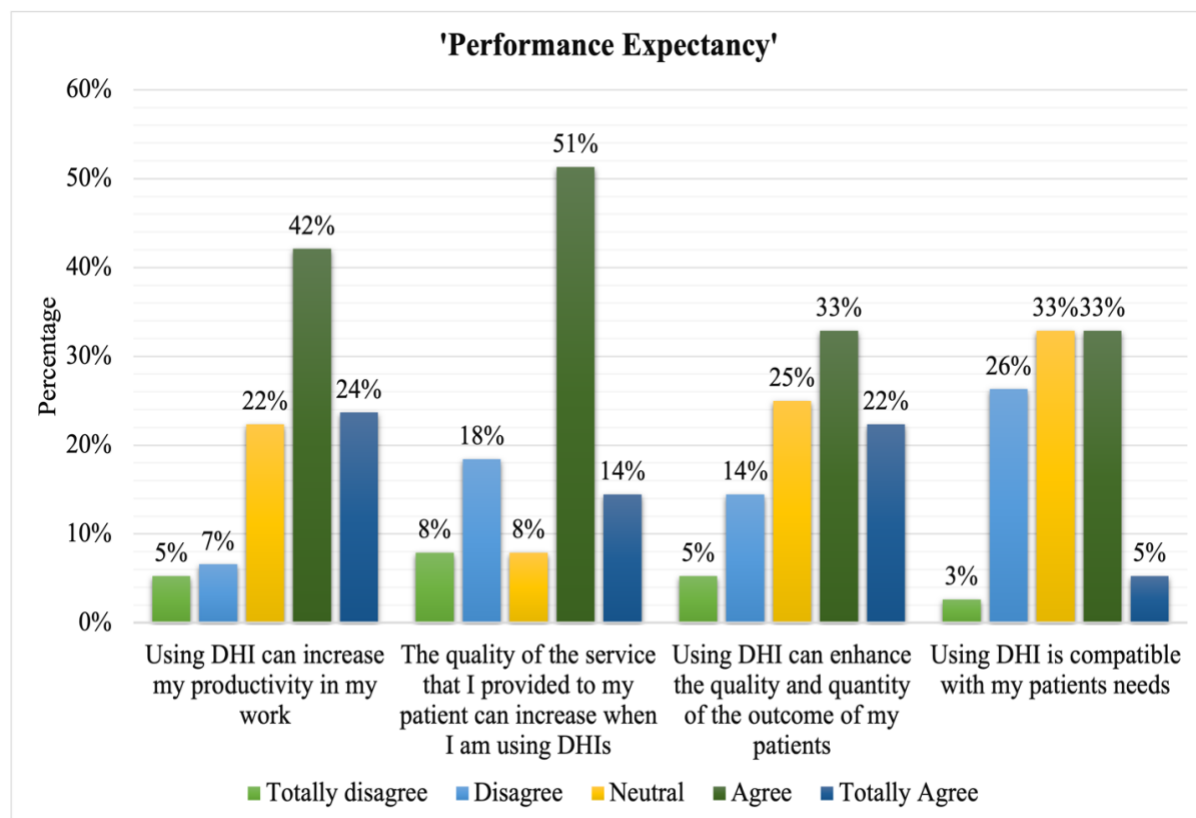
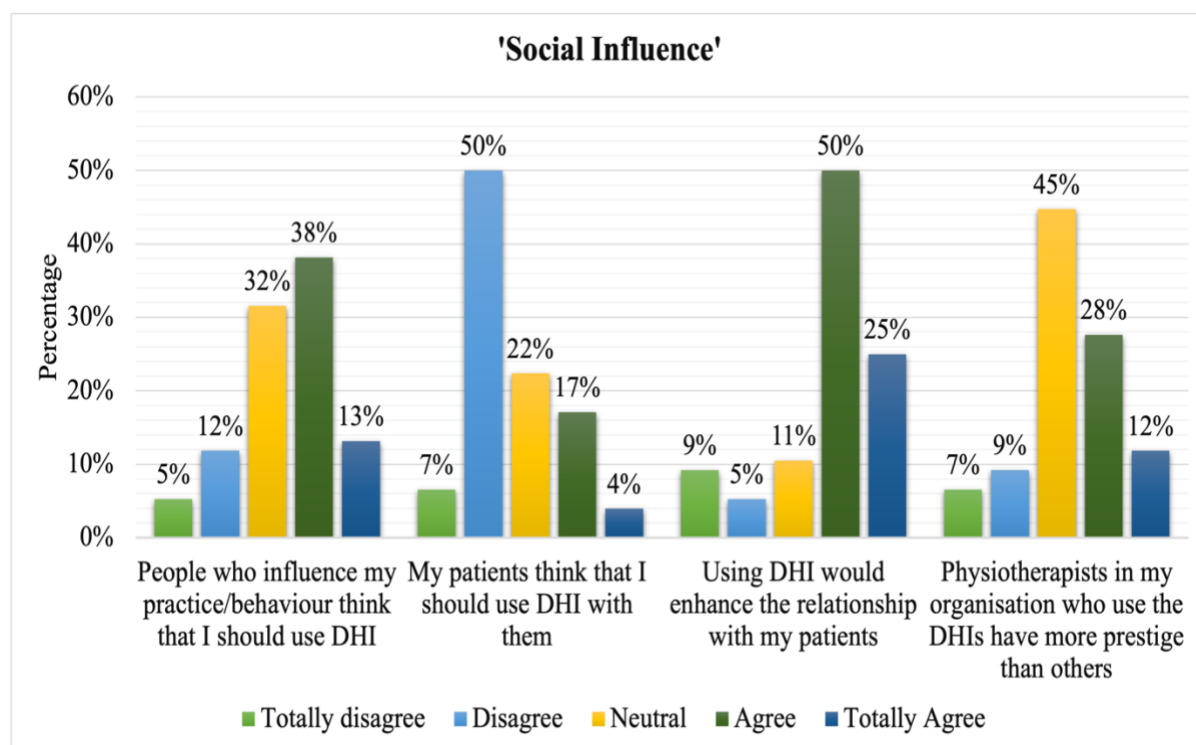


Figure 5 shows that the largest percentage of physiotherapists (42%) agreed with the statement 'using DHI can increase my productivity in my work'. In addition, most physiotherapists provided their agreement 65% (51% agreeing and 14% totally agreeing) that using DHI can enhance the treatment quality provided to patients. Additionally, the bar chart indicates that the majority (55%) of physiotherapists agreed that DHI improves patients' outcomes. However, opinions were divided regarding the compatibility of DHI with patient needs because less than two-fifths (38%) agreed that DHIs were compatible with patients' needs, nearly one-third disagreed (29%), and another third remained neutral (33%). Compared to the other statements, the last statement revealed mixed views among the physiotherapists, although the majority believed that DHI could enhance their productivity and improve the quality of the services provided to their patients.

Figure 6: Social influences of Digital Health Intervention among physiotherapists (n=76)



The social influence, shown in **Figure 6**, for the first statement, 'People who influence my practice think that I should use DHI', showed the largest percentage (38%) agreed, and an additional 13% of physiotherapists totally agreed. However, there was also a significant neutral response (32%), and some disagreement (17%). The second statement received more negative than positive responses; more than half (57%) of the physiotherapists disagreed that patients thought physiotherapists should use DHIs with them, while only 21% agreed. Regarding the third statement, most of the physiotherapists were in favour, with 75% of the respondents agreeing that DHI enhanced their relationship with their patients and only a small percentage (14%) disagreeing. Additionally, physiotherapists view for the last statement were mixed but leaned towards neutrality, as almost half (45%) remained neutral, 40% agreed and 16% disagreed.

Figure 7: Facilitating condition of Digital Health Intervention among physiotherapists (n=76)

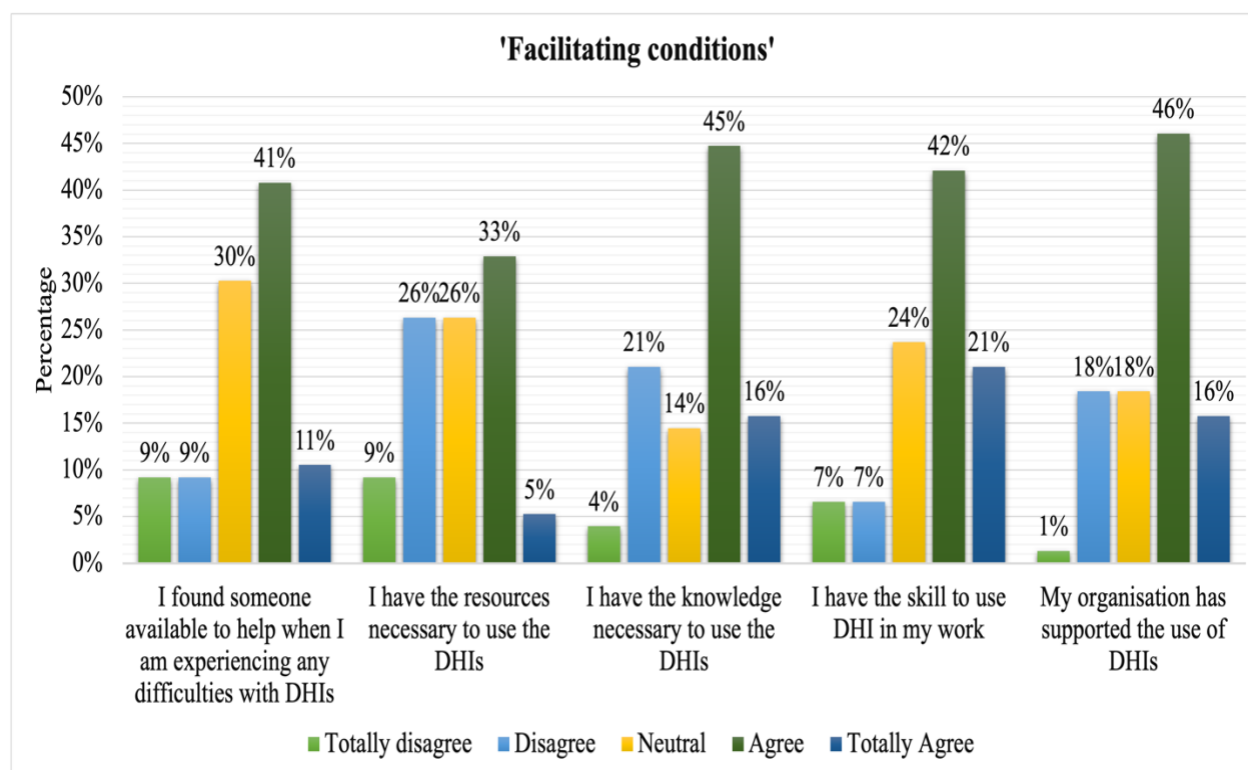


Figure 7 shows the facilitating conditions of using DHI based on five statements. Regarding the first statement, 'I found someone available to help when I am experiencing difficulties with DHIs', more than half of physiotherapists agreed (52%), while 30% remained neutral and 18% disagreed. In contrast to the first statement, the second statement concerning whether physiotherapists had the necessary resources to use DHIs presented mixed responses; fewer than two-fifths (38%) agreed, whereas more than one-third (35%) disagreed and approximately one-quarter (26%) were undecided. Furthermore, it can be clearly seen that the majority of physiotherapists showed they have the necessary knowledge to use DHI (61% agreed or totally agreed) and skills (63% agreed or totally agreed). In addition, a significant number of physiotherapists also perceived that their organisation supports the usage of DHI (62% agreed or totally agreed).

Figure 8: Cultural factors of Digital Health Intervention among physiotherapists (n=76)

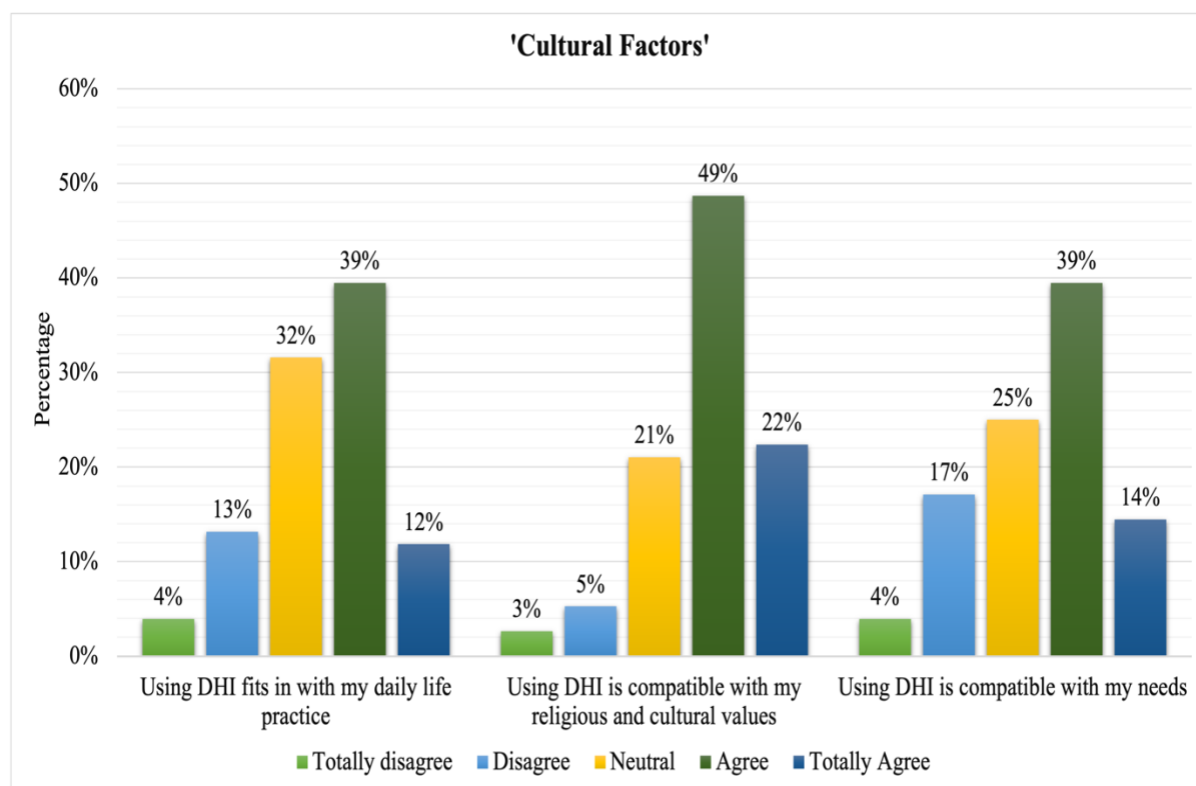


Figure 8 shows the percentage of physiotherapists who provide their agreement regarding the cultural factors, including three statements. Regarding the first statement, 'using DHI fits in with my daily life practice', it shows that half (51%) of physiotherapists agreed with this statement. However, a notable proportion also was neutral regarding this statement (32%). Furthermore, the second statement shows that a large percentage of physiotherapists expressed that DHI is compatible with their religious and cultural values (71% agreed and totally agreed). Finally, the last statement shows the largest percentage of agreement (53%) than disagreement (21%).

Overall, it can be clearly seen that most physiotherapists tended to agree with the construct of performance expectancy, except for the compatibility of the DHI with their patient's needs. In addition, related to effort expectancy, most of the physiotherapists provided their agreement with the ease to use of DHI; however, they also provided their concern about the usability of DHI among their patients. Social influence on DHI usage among physiotherapists is mixed, with some agreement that DHI enhances patient relationships, but some disagreement about patient expectations of DHI usage and neutrality regarding the prestige associated with DHI use. Considering the facilitating condition construct, based on the percentage, it seems that physiotherapists agreed that they have the knowledge and skills to use DHI in their work, and the organisation supported the use of DHIs. However, there were some mixed views regarding the availability of the resources necessary for DHI usage. Furthermore, regarding cultural factors, the findings indicate that physiotherapists perceived that DHI is compatible with their cultural and religious values. However, just over half of the physiotherapists agreed with the compatibility of DHIs in their daily life practices and with their needs.

Figure 9: Levels of behavioural intention and regular use of Digital Health Interventions among physiotherapists (n=76)

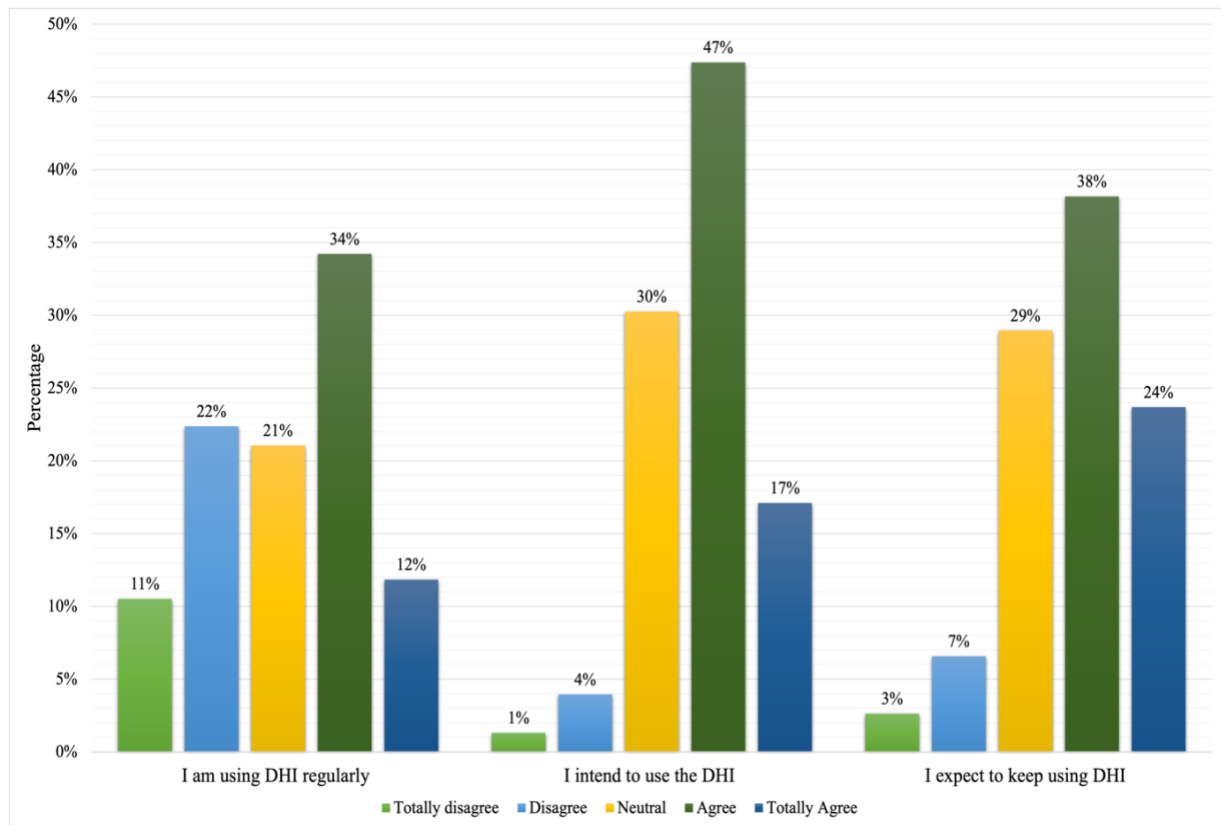
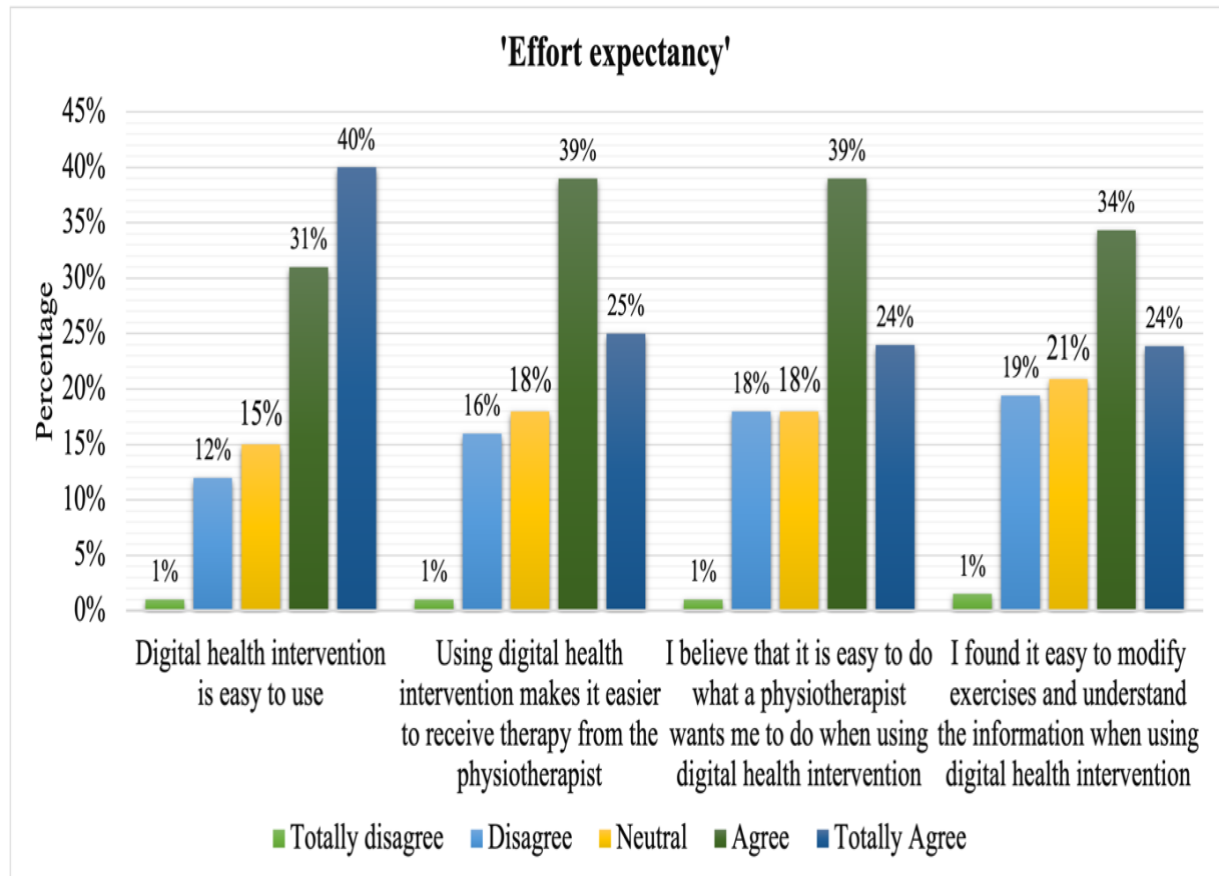


Figure 9 shows the behaviour intention, regular use and expected level of continued use of the DHI. With regard to the regular use, 46% of physiotherapists declared agreement with the regular use of DHI. However, 21% were neutral, and 33% of the physiotherapists acknowledged disagreeing with using DHIs regularly. The agreement of the expectation (62%) and the intention (64%) to use DHIs is higher than the regular usage by physiotherapists.

4.5.4 Understanding the utilisation of Digital Health Interventions among MSK patients: Insight from UTAUT factors.

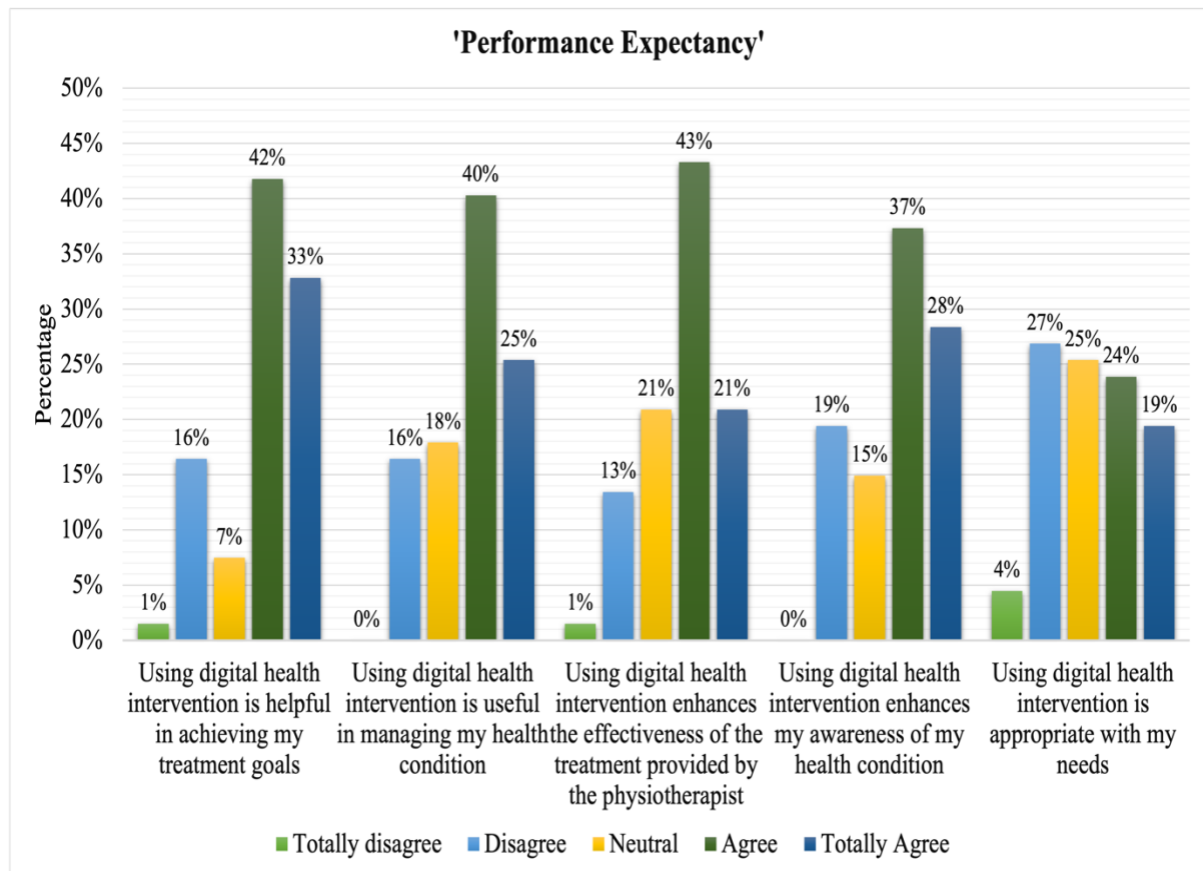
This section aims to provide an understanding of MSK patients' perspectives on the use of DHI in Saudi Arabia. The understanding of the factors that limit or facilitate the use of DHI is based on the UTAUT model along with the cultural factors. **Figure 10** provides an overview of MSK patients' perception of using DHI based on effort expectancy, **Figure 11** is based on performance expectancy, **Figure 12** is based on social influences, **Figure 13** is based on facilitating conditions, and **Figure 14** is based on cultural Factors. **Figure 15** provides the overall view of regular usage and behavioural intention to use DHIs among MSK patients. These figures represented the MSK patients' views based on the percentage.

Figure 10: Effort expectancy of Digital Health Intervention among patients with musculoskeletal conditions (n=67).



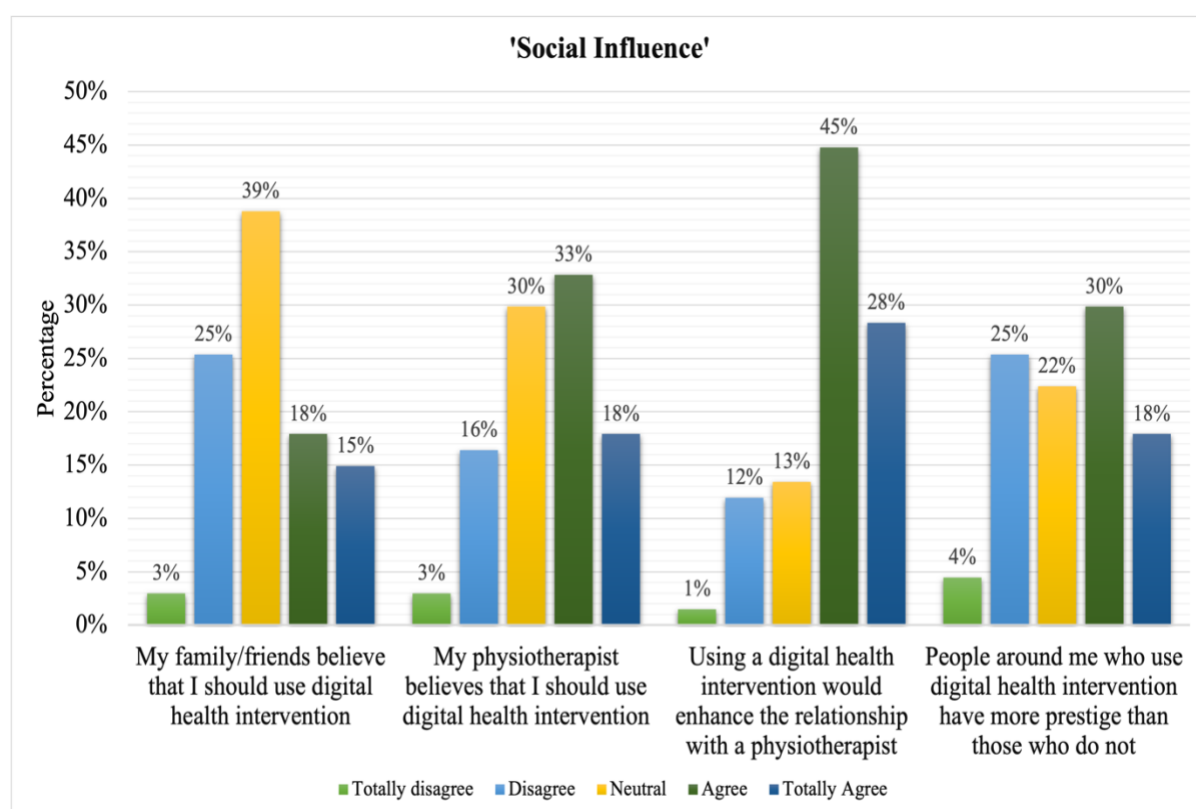
Four statements presented in **Figure 10** show MSK patients' agreement levels for the construct of effort expectancy. The first statement had the largest percentage of total agreement among MSK patients regarding easy-to-use DHI (71%) as most patients agreed with this statement. However, there was some dissent, as 15% of patients remained neutral, and also a minor percentage 13% of MSK patients disagreed. Additionally, the majority also agreed with the second (71%), third (63%) and last statements (58%). However, there was some disagreement or neutrality among the MSK patients for all four statements.

Figure 11: Performance expectancy of Digital Health Intervention among patients with musculoskeletal conditions (n=67)



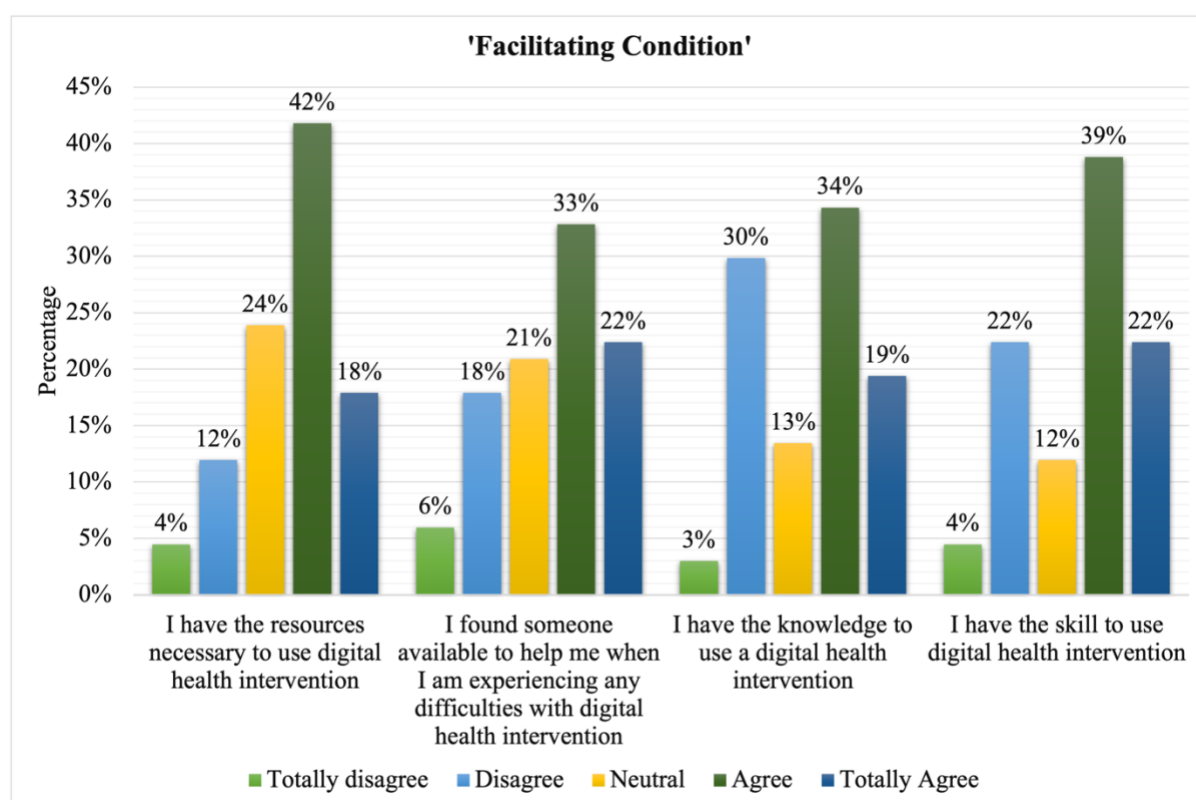
Five statements are presented in **Figure 11**, which show the performance expectancy construct of using DHI. The majority of patients agreed with all of the statements, except for the last statement, which showed different agreement. MSK patients' views were quite mixed. This is because less than half of the participants agreed that DHI was compatible with their needs. In addition, a slightly larger proportion either disagreed (27%) or totally disagreed (4%) and a quarter remained neutral, resulting in a disagreement percentage higher than for the other statements.

Figure 12: Social influences of Digital Health Intervention among patients with musculoskeletal conditions (n=67)



Four statements presented in **Figure 12** show the social influences of using DHI. The first statement of social influence demonstrates less agreement than the other constructs, with considerable variation in participants' views. MSK patients provided slightly mixed responses to the statement 'My family/friends believe that I should use digital health intervention', with 33% agreeing, 28% disagreeing and a larger proportion (39%) remaining neutral. There was greater agreement with the second statement, which refers to patients' belief that their physiotherapist thinks they should use DHI; half of the MSK patients agreed with this statement, whereas only 19% disagreed. Despite these mixed perspectives on social influences and perceived expectations from physiotherapists, it is noteworthy that the majority of MSK patients (73%) agreed that using DHI enhanced their relationship with their physiotherapists. The slightly mixed responses to the last statement regarding the perception of high prestige among DHI users and non-users tended towards agreement because just less than half of the patients agreed (48%), whereas 29% disagreed.

Figure 13: Facilitating conditions of Digital Health Intervention among patients with musculoskeletal conditions (n=67)



Four statements presented in **Figure 13** show the agreement regarding the facilitating condition of using DHI among MSK patients. Patients reported their agreement with the statement 'I have resources necessary to use digital health intervention' with more than half (60%) showing their agreement. In contrast, responses were quite diverse for the second statement, 'I found someone available to help me when I am experiencing any difficulties with digital health interventions. Many patients supported this statement, with 55% totally agreeing and agreeing, but 24% of MSK patients noted their disagreement. The third statement shows that the patients' responses were mixed, but the majority perceived them as knowledgeable regarding the use of DHIs because more than half (53%) agreed, but one-third (33%) disagreed. Similarly, patients appeared to perceive themselves as having the skill to use DHIs because the majority (61%) of patients agreed with the final statement, whereas a quarter (26%) disagreed.

Figure 14: Cultural factors of Digital Health Intervention among patients with musculoskeletal conditions (n=67)

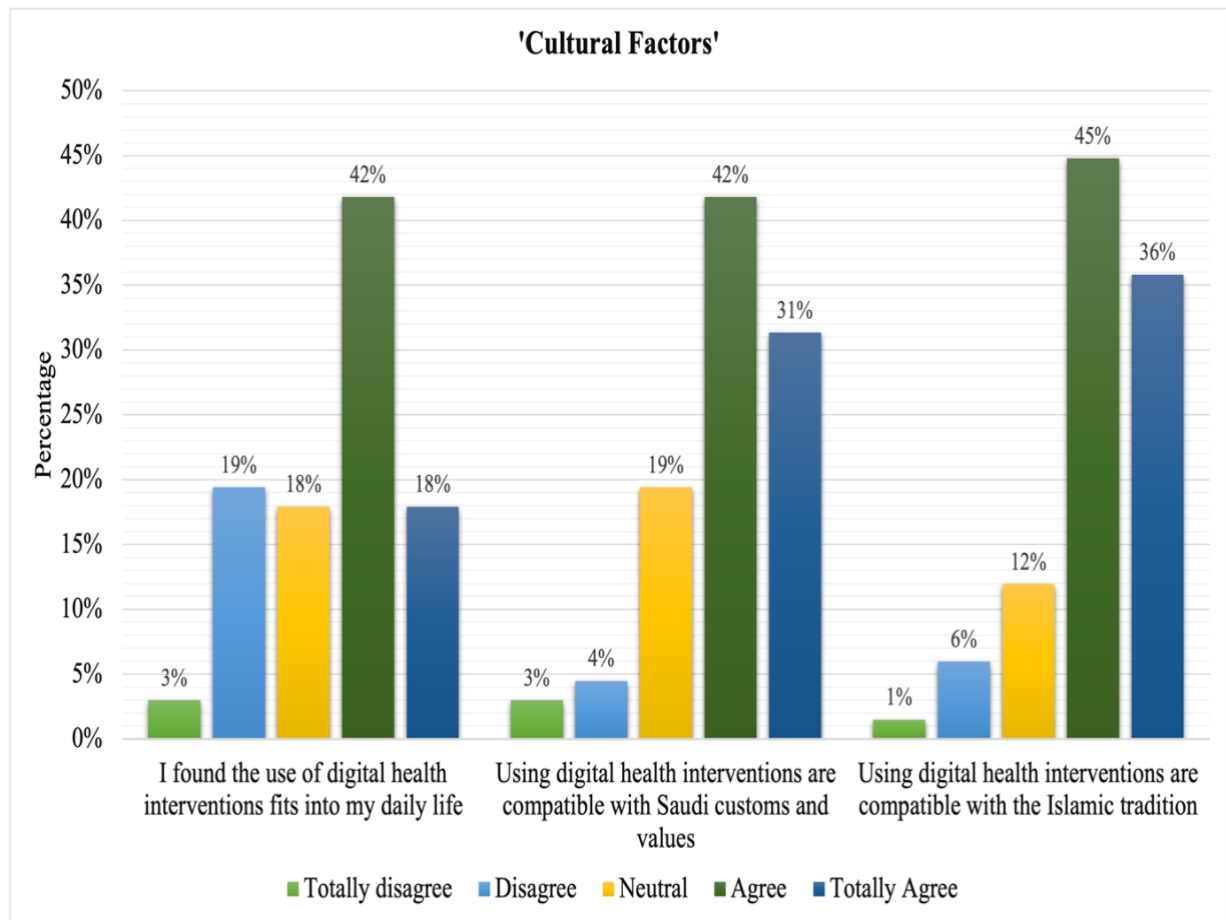


Figure 14 displays the percentage of agreement and disagreement for the construct of cultural factors, consisting of three statements. For the first statement, responses varied: the majority of patients agreed (60%), but there was also some uncertainty regarding this statement, as evidenced by the 22% who disagreed and a further 18% who remained neutral. The patients also recorded the largest percentage for the compatibility of the DHI with Saudi customs and values, as evidenced by 73% of MSK patients (31% totally agreeing and 42% agreeing). Similarly, a clear majority of patients (81%) agreed with the last statement, which showed that they perceived the compatibility of the DHI with their religion; only a small percentage (7%) disagreed regarding the compatibility of the DHIs with religious beliefs.

Overall, regarding effort expectancy, most of the MSK patients found DHIs to be easy to use and helpful in terms of modifying exercises and understanding information. However, some patients expressed disagreement and neutrality. Similarly, with regards to the performance expectancy construct, the overall percentage indicates that patients mostly have a positive attitude towards using DHIs. Nevertheless, the patient provided mixed views on the compatibility of the DHI with their needs, as has shown in **Figure 11**. In contrast, considering social influences, the bar chart shows mixed responses regarding patients' beliefs about receiving support from family or friends when using DHIs, and their perceived prestige among DHI users. However, most of the MSK patients agreed regarding physiotherapists' expectations for using DHIs and that using DHIs enhanced their relationships with them. The patients also agreed on the facilitating conditions, expressing agreement with most of the statements. Finally, in terms of cultural factors, the patients surveyed tended to fully agree with the compatibility of DHIs with religious factors and with other cultural values. Although the majority agreed that DHIs were compatible with their daily life practices, there was more disagreement regarding this statement than the other statements relating to the cultural factor.

Figure 15: Levels of behavioural intention and regular use of Digital Health Intervention among patients with musculoskeletal conditions (n=67)

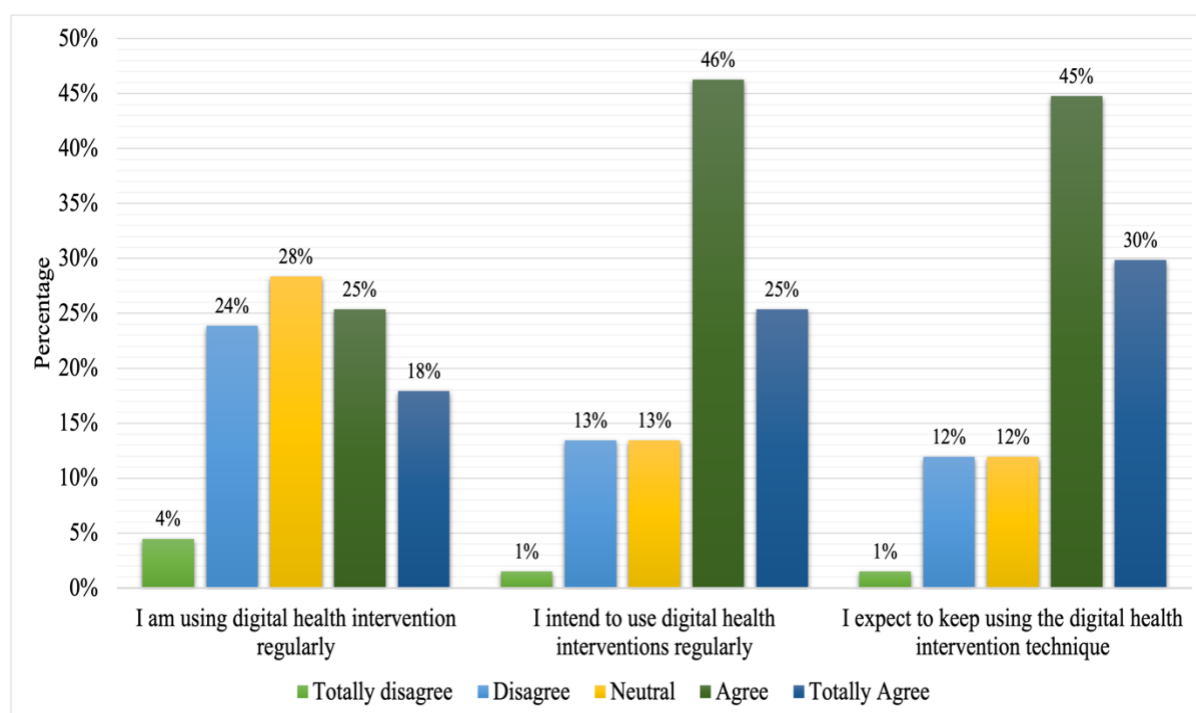


Figure 15 illustrates the level of regular usage, intend and expected continued use of the DHIs. Regarding the regular use of DHIs, approximately 43% of the respondents reported engaging with them regularly. However, it is noteworthy that 28% expressed disagreement regarding consistent DHI usage, whilst a further 28% remained neutral. A clear majority of participants (71%) agreed or totally agreed that they intended to use DHIs, with only a small percentage indicating non-acceptance of using DHIs. Additionally, 75% of the patients (30% totally agreeing and 45% agreeing) expected to continue using DHI. The chart presents a positive perspective regarding the intention and expectation to continue using DHI, although the regular usage rate appears to be lower than the intended usage. The qualitative findings in **Chapter 7** will shed light on these figures and provide possible explanations for this discrepancy.

5.1.4 Summary

In regard to patients' characteristics, the most common condition response to complete the survey was from patients with LBP, followed by arthritis, with most of them having chronic conditions (suffered for more than one year). The use of DHI was limited in this period, as both participants had limited use of DHI. Most patients reported less than two months, and most physiotherapists reported two months of experience. A large percentage of both patients and physiotherapists received advice or training, respectively. Additionally, regarding the UTAUT, it appears that for most of the statements, there is a high level of agreement that reflects each construct of UTAUT; even though some statements show a low level of agreement between physiotherapists and MSK patients.

Physiotherapists expressed mixed views regarding their beliefs that it was easy for patients to use DHI and that using DHI was compatible with patients' needs. Patients similarly demonstrated mixed views regarding the compatibility of DHIs with their needs, although they tended to agree regarding the compatibility. Furthermore, both patients and physiotherapists agreed that DHI enhances the therapeutic relationship between them, however, there were also some mixed views regarding the social influence construct for both groups. Regarding the construct of cultural factors, both patients and physiotherapists indicated a high level of agreement that using DHIs aligns with religious and cultural values. However, there was some degree of disagreement concerning the compatibility of DHIs with physiotherapists' needs as well as their fit within daily life practices. Despite high intention rates to use DHIs among patients and physiotherapists, only 46% of physiotherapists and 43% of patients reported regular usage. Despite these perspectives, patients and physiotherapists have positive expectations to continue using DHI. This highlights an area that needs to be addressed to achieve consistent and regular DHI utilisation.

5.2 Discussion

This study examined the overview of the patients' and physiotherapists' characteristics and factors that might act as barriers or facilitators to using DHI at the five hospitals in the two cities of Saudi Arabia (Makkah and Taif). To meet the research objectives and answer the research question, this was done by utilising an online-based survey based on the UTAUT and cultural factors, through a cross-sectional design, for two populations (MSK patients and physiotherapists). This section will provide an overview of the demographic data and general information concerning DHI in Saudi Arabia; the following section will demonstrate barriers and facilitators to using DHI among physiotherapists and patients. Finally, the clinical implications, strengths, and limitations of the study will be provided.

5.2.1 Demographic data for physiotherapists utilising DHIs with MSK patients in Saudi Arabia

The results indicate that males and females were almost similar for physiotherapists who utilise DHI in Saudi Arabia. In addition, most of the participants' ages ranged between 25-35 years, which was similar to previous studies that indicate younger physiotherapists might intend to utilise DHI more than older physiotherapists (Kloek et al. 2020; Leese et al. 2019). The potential reason for this finding is that the younger population might find it easier to provide DHI than the older physiotherapists with more experience in a face-to-face session. Additionally, more than half of the physiotherapists, 55%, have used DHI for up to 2 months, while few utilised DHI for more than one year (7.9%). This finding is similar to Leese et al. (2019), who found that 36% of healthcare providers utilise DHI, and Kloek et al. (2020), in which only 11% of physiotherapists used DHI after two months of the intervention period. The

possible barrier to decreased engagement with physiotherapists is explained in more detail in the following sections.

95% of the responders were employed in the public hospital, and this discrepancy may indicate an underrepresentation of physiotherapists working in private sector in the current survey sample. For physiotherapists working in public hospitals where the MOH mandated DHI utilisation across all departments as part of its Vision 2030 objectives, this factor could significantly impact their perspective towards delivering DHIs. Furthermore, the impact of COVID-19 on these findings should also be considered. It should be noted that the current study primarily reflects the views of those working within public healthcare settings and during a unique global health crisis period and therefore, direct comparisons with previous studies conducted under different circumstances or within the private sector may lead to inaccurate comparisons. Therefore, these findings should be interpreted with caution when considering these essential factors.

5.2.2 Barriers and facilitators for utilising DHIs in Saudi Arabia from physiotherapists' perspective

The majority of physiotherapists agree with the performance expectancy construct and effort expectancy, which indicate that these two factors could act as facilitators to enhancing physiotherapist engagement with DHIs. However, there were some mixed views regarding the compatibility of DHI with patients' needs, thereby indicating that physiotherapists could have different experiences regarding this aspect, which requires further clarification. As Venkatesh et al. (2003) emphasised, it is important to consider the compatibility of the technology with the end-user's needs. Furthermore, researchers have demonstrated a lack of consideration of patients' needs, leading to a lack of engagement with DHI. Birnbaum et al. (2015) revealed that

a lack of consideration of patients' viewpoints during the development of DHI can lead to low levels of engagement. Therefore, it is crucial to understand both physiotherapists' and patients' perspectives of their experiences and requirements.

Furthermore, most physiotherapists agreed that it was easy to use DHI in their practice. This finding is similar to Liu et al.'s (2014) work, demonstrating that effort expectancy might act as a barrier to using DHI at the beginning, but ultimately had no impact on using DHI. However, there remains a minority who may find DHI challenging to learn and use that suggests that there could be other factors influencing perceptions about DHI usage efforts such as a lack of training. Furthermore, the physiotherapists were divided regarding whether patients found DHIs easy to use. These discrepancies highlight areas requiring further investigation.

Physiotherapists most commonly expressed negative views regarding social influence relating to DHI, with a majority (57%) disagreeing that patients believe they should use it. This finding suggests an area requiring further investigation and discussion among both patients and physiotherapists. In addition, the high level of neutrality towards statements concerning the prestige and influence of colleagues using DHI may suggest that others' practices do not influence them and this finding is in accordance with the conclusions of previous studies (Liu et al. 2014). Liu et al. (2014) showed that social influence can only affect physiotherapists' decision-making in terms of mandatory requirements. However, it is crucial to acknowledge that the nature of a healthcare system can influence an individual's attitude towards using DHIs. This understanding calls for more in-depth research to accurately comprehend these influences.

Even though most physiotherapists indicate that having the skills and knowledge to use DHI indicates a positive attitude towards facilitating construct, opinions varied regarding the

availability of resources necessary to use DHI. The overall percentage of physiotherapists who reported having the resources to use DHI (38%) was lower compared to percentages for other statements within the facilitating condition construct, indicating a limited infrastructure for the organisation provided to the physiotherapists, which might act as a barrier for utilising DHI in Saudi Arabia. This data is similar to previous studies, which provide evidence for the benefit of more substantial infrastructure and provide a more extraordinary attitude to use DHI, which was recommended before implementing DHI in clinical practice (Liu et al. 2014; O'Connor et al. 2016). Vaart et al. (2016) confirm that non-users can be predicted by limiting facilitating conditions in the organisation, and thus facilitating conditions are considered one of the barriers that might hinder physiotherapists from utilising DHI in Saudi Arabia.

Cultural factors led some physiotherapists to believe that DHI does not align with their daily life practice, a finding that is consistent with previous studies citing workload and time constraints as barriers to DHI use. These aspects require further exploration for a deeper understanding and confirmation. Interestingly, the current study found that the majority of the respondents agreed regarding the compatibility of DHIs with culture and religion. This was in contrast to the findings of Ly et al. (2017) who examined how culture and religion can influence healthcare provider-patient interactions during DHI use. The differences observed may be due to country-specific or context-specific factors; while positive insights regarding cultural compatibility were noted in the current study, other culturally related work or professional challenges may still exist. As Ehrari et al. (2022) emphasised, understanding these elements is key for successful digital transformation within the healthcare sector and this warrants further investigation in the following research phase.

Furthermore, one factor that might also act as a barrier is limited training, as both Button et al. (2018) and Bhattarai et al. (2020) show that physiotherapists must receive training before utilising this type of intervention and that they must be given sufficient time to familiarise themselves with DHI to enhance their skills in utilising it. Therefore, training before adopting and implementing DHIs can be considered a crucial facilitator for providers. Furthermore, both Button et al. (2018) and Bossen et al. (2016) trained their therapists in the platform before allowing them to use their DHIs. Thus, in the current study, the majority of the physiotherapists responded that they had not received any training before utilising DHI, which might act as a barrier to using DHI and requires further investigation to confirm this finding.

5.2.3 Demographic data for Saudi patients with MSK who use DHIs.

As described in the results section, most patients who utilised DHIs were female (85%) and well-educated. As discussed in the introduction chapter, the predominance of female respondents in the current study aligns with previous research showing a higher prevalence of MSK conditions among females than males. Furthermore, previous studies have reported similar findings and represent MSK patients highly educated women are more likely to use DHIs (Allen et al. 2018; Bennell et al. 2018; Bossen et al. 2013; Carpenter et al. 2012; Chiauzzi et al. 2010.; Nordin et al. 2018; Irvine et al.). This data may suggest that well-educated patients often demonstrate a higher level of understanding; however, caution should be taken when interpreting these results. While non-educated patients are less represented in this survey, even though they constitute a smaller percentage according to the survey findings, usage is not limited only to highly educated people. Further investigation into this aspect would be beneficial and can be explored during the subsequent phase.

In addition, patients with LBP were most prevalent in the current sample, followed by those with arthritis, which aligns with previous studies confirming the high prevalence of LBP among Saudi Arabian populations (Meisha et al. 2019; Felemban et al. 2021). The high percentage of LBP in the current study may be explained by work conditions that require prolonged standing or sitting for extended periods for those patients, factors known to increase the risk of developing LBP. It should be noted that this study did not aim to identify the prevalence of patients with MSK conditions; rather, its purpose was to explore demographic data among participants who have experience using DHIs in Saudi Arabia. As this study employed a cross-sectional design, these findings are representative only at one point in time and cannot necessarily be generalised across all populations. A systematic review by Hewitt et al. (2020) found that most studies of DHIs use them to treat LBP patients. This may indicate that more research is necessary regarding the use of DHIs to treat LBP, but there is a chance that the labelling may not be accurate, as patients might report having arthritis in their back. Therefore, further research is needed to compare and confirm these findings.

The survey results also indicated that most participants had suffered from their condition for more than one year. Patients with chronic conditions may require long-term management plans, highlighting the need for self-management strategies, as suggested by the guidelines. Conversely, according to previous guidelines, acute cases are often initially treated with anti-inflammatory medications (Oliveira et al. 2018; Qaseem et al. 2020), suggesting that they might not necessitate prolonged management like chronic conditions. Chronic cases might benefit from self-management interventions, particularly if these interventions include psychological insights, as psychological factors can play a role in chronic MSK conditions (Hewitt et al. 2020). However, these findings cannot be generalised due to the small sample

size of MSK patients in Saudi Arabia represented in this study. Therefore, further research is needed to validate these potential explanations.

5.2.3 Patients' barriers and facilitators to utilising DHIs in Saudi Arabia

Overall, patients in Saudi Arabia expressed positive views regarding the use of DHI. There was a high percentage of agreement among MSK patients concerning performance expectancy. Many patients perceived significant benefits from using DHI, thereby indicating its potential usefulness. Similar studies have demonstrated the same view regarding the benefit of DHI among MSK patients (Hewitt et al. 2020; Valentijn et al. 2022). However, some participants disagreed regarding the compatibility of DHI with their needs, despite acknowledging its overall benefits. This result can also be explained by Venkatesh et al. 's (2003) view that individuals' perceived benefit of using new technology affects their desire to use it. Previous studies have reported similar results, demonstrating that patient needs may vary and, therefore, lead to a lack of engagement with DHI (Parker et al. 2013; Zuidemia et al. 2019). This finding emphasises that whilst DHI can benefit the health management strategies of many individuals, they may only meet some people's specific requirements or preferences.

The social influence construct revealed mixed views regarding patient agreement for most of the statements. The first statement in **Figure 10** concerning patients' belief in their family and friends using DHI indicated neutrality rather than clear agreement or disagreement. This suggests that patients either did not perceive sufficient support to engage with DHI or did not understand the type of support needed from family and friends. Interestingly, most of the patients agreed that DHI enhances relationships with their physiotherapists. Mixed views were

also observed regarding beliefs about others' prestige associated with using DHIs that suggests that some may not perceive these tools as important status symbols linked with positive behavioural attitudes towards those who use such interventions. These findings could be due to various reasons, warranting further investigation to achieve a more comprehensive understanding of patient experiences in Saudi Arabia.

Furthermore, most of the patients in the current study agreed with the effort expectancy construct, indicating that they found DHIs easy to use. This result is in accordance with Liu et al. 's (2014) research, thereby suggesting that whilst effort expectancy can be an important factor during the initial stages of learning a new technology, its influence diminishes over time as users become more familiar with DHI. Interestingly, this study was conducted during the COVID-19 pandemic, which may have influenced patient perceptions about DHIs due to increased reliance on digital health solutions. This trend was noted by Alkhalifaha et al. (2022) who reported higher utilisation rates for these interventions compared to in pre-pandemic times. Therefore, factors like familiarity over time and external circumstances such as COVID-19 can affect perceptions of the ease of DHI usage. As such, these influences warrant further exploration.

Moreover, most patients agreed that the resources necessary for DHI use were available, including assistance when experiencing difficulties and having the requisite knowledge and skills. This finding suggests that sufficient infrastructure supporting DHI usage as per the UTAUT model is required (Venkatesh et al. 2003). However, facilitating conditions may not significantly influence whether or not an individual will use technology (Philippi et al. 2021). This finding demonstrates that even if the infrastructure exists and the resources are available,

whether a person uses a particular technology is influenced by other factors. Therefore, **Phase II** of this study could provide valuable insight regarding this concept.

In terms of cultural factors, the majority agreed that DHI is compatible with their religion and culture. This contrasts with the findings of previous studies such as Ly et al. (2003) which emphasise the negative effects of culture and religion on patients' DHI use. This discrepancy suggests that cultural and religious influences vary, possibly due to context-specific or other factors. A more comprehensive understanding of these disparities may be achieved by exploring both patients' and physiotherapists' views regarding DHI compatibility within the specific context of Saudi Arabia.

5.2.4 Implications for practice

This study's findings offer significant insight into the concerns relating to DHI use from patients' and physiotherapists' viewpoints, indicating that several factors may influence DHI usage in Saudi Arabia. The results also enable a comparison between patient and physiotherapist perspectives, which could aid effective development regarding patient needs and acceptance of DHI. Future research may benefit from conducting interviews with patients and physiotherapists to better understand these important factors, thereby identifying strategies to boost engagement with DHIs.

5.2.5 Strengths and limitations

This study is the first to explore the barriers to and facilitators of DHI use from the perspectives of patients and physiotherapists in Saudi Arabia. Comparing the views of these two groups can lead to exciting results and new knowledge. The present study was conducted in seven hospitals in Saudi Arabia, most in Makkah and Taif; this fairly broad sample enhances the

generalisability of the study's findings (Portney and Watkins 2013). However, the sample of patients included considerably more female than male participants (85% female and 15% male patients), which might negatively impact the representativeness of the findings; therefore, caution should be used in generalising these findings to Saudi males. Furthermore, the participants who responded to the questionnaire might have been motivated to use DHI. The QR code for the survey was posted in the hospitals for over five months. However, the overall response rate could have been higher, indicating that most patients who visited the hospitals during the study period did not respond to the survey.

Although the current study offers valuable insight into DHI usage among MSK patients and physiotherapists, it is crucial to interpret these findings with caution due to several factors which may have influenced the results of this study. To illustrate, electronic surveys were utilised due to the COVID-19 restrictions, which made using paper copies unfeasible. This methodological choice could introduce bias towards those able to utilise technology being included in the sample. Additionally, it is also important to consider how the context of the COVID-19 pandemic might have affected participation rates and demographics. Many individuals avoided hospital visits unless absolutely necessary during this period, which could further skew the samples towards those who are more comfortable with technology for health-related purposes. Therefore, these potential biases should be considered when interpreting the findings of this study and the pool of participants may not truly represent those who are less comfortable using technology or who are unable to use it.

The main limitation of the current study is that the data were collected at one point in time; no longitudinal data were collected from patients or physiotherapists. Longitudinal data collection would enrich this study by providing insights into the long-term effects and usability of DHIs.

It would allow for understanding how perceptions and experiences evolve over time among patients with MSK disorders and physiotherapists. Future studies should use different research methods, particularly for the patient population, to gather sufficient data to confirm the current study's findings. The UTAUT questionnaire used in the present study enabled a deeper analysis of the different factors that influence DHI use. The primary strength of this model is that it enabled an in-depth exploration of different models and theories.

5.3 Summary

The findings showed that, although DHIs are available, there exist some concerns among patients and physiotherapists, which might influence their use of DHIs. Almost 90% of participants received no training before using a DHI, which requires further investigation. In addition, the UTAUT model provided an overview of the main factors that might impact DHI use, such as facilitating conditions, social factors, and cultural factors. However, all of these factors need to be investigated in more depth to collect precise data to support and empower both physiotherapists and patients. In addition, more attention to patient needs and the development of more resources and support for physiotherapists would enhance DHI engagement in Saudi Arabia. Further qualitative research is needed to clarify the impacts of the studied factors on both patients and physiotherapists. This research was conducted in the next phase of the study.

Chapter 6

Qualitative Method

Chapter 6: Qualitative Method (Semi-Structured Interview) Methods (Phase II)

6.1 Introduction

This section presents the qualitative phase that explored patients' and physiotherapists' experiences after using and providing DHI. This phase aimed to expand upon previously shown findings (**Chapter 4**). Conducting this phase allowed me to determine critical elements, including overall experiences and beliefs towards utilising and delivering DHI in Saudi Arabia. UTAUT was also considered, and this qualitative phase will outline how this theory was utilised. Operating theory research offers one way of improving the understanding of changing behaviour through systematically identifying relevant factors and allows researchers to guide evaluation processes (Phillips et al. 2015).

6.2 Data collection

In this phase, I used a descriptive semi-structured interview as the data collection method, conducting it with physiotherapists and patients diagnosed with MSK conditions. I aimed to gain a deeper insight into patients' and physiotherapists' experiences while understanding potential barriers or facilitators to use DHI within these populations to give more in-depth knowledge about this subject matter. A gap in the existing literature was identified through a comprehensive search, which was guided by a scoping review. The findings from the scoping review revealing limited studies exploring real-life experiences of DHI use in everyday settings. Qualitative methods, such as individual interviews, provide the solution to bridge this gap. As stated in **Chapter 5**, during the analysis of the second phase (**Chapter 5**), several elements required further exploration. Therefore, this phase fills gaps in the literature to understand previous findings better. To illustrate, survey findings (**Chapter 5**) revealed a generally positive attitude toward UTAUT statements among patients and healthcare providers

yet only a low percentage of regular use was noted among both sets of participants. As both MSK patients and physiotherapists firmly intended to use DHI for future applications and this suggests that different barriers could prevent both parties from engaging with DHI effectively. Therefore, conducting individual interviews allowed me to gain further insights into participants' views on DHI.

6.2.1 Aim of this phase

- To understand the barriers and facilitators to MSK physiotherapists' recommendation and use of DHI.
- To understand the barriers and facilitators to MSK patients' acceptance and use of DHI.
- To develop recommendations to aid and enhance the use of DHI in treating MSK conditions with the involvement of patients and physiotherapists.

6.2.2 Recruitment

Participants from Phase I who expressed interest in further study were sent invitations via WhatsApp or email with an attached information sheet, followed by consent forms and schedules, and then a secure link was sent via Zoom. I created a Zoom link with password protection for confidentiality and privacy (only the researcher and the participant can join this link), along with the scheduled time slots and Zoom links, if applicable. A reminder was then sent before each day so participants could ensure they could make it for interviews on time or adjust it if needed. Recruitment of participants for Phase II was highly challenging, although there was an adequate response from patients who had been involved in Phase I. It should be noted that surveys are the predominant research method used among Saudi populations (Jahan et al. 2017), which may lead to a relative lack of familiarity with interviews and other

qualitative methodologies in the Saudi population. Thus, both patients and physiotherapists needed help understanding how interviewing can benefit researchers by helping address issues not captured through quantitative studies (Creswell and Poth 2018).

Though cultural norms relating to gender segregation presented challenges in recruiting male patients, these barriers did not occur when recruiting male physiotherapists living under similar societal environments. Their professional environments may explain this discrepancy (Alghamdi et al. 2017), as in healthcare education at universities and within hospital settings where they work, there is no strict adherence to gender segregation, a situation quite different from that experienced by many potential patient participants (Hamdan 2005). Male doctors educate female students and vice versa; similarly, female and male physiotherapists interact regularly in hospitals. Therefore, as a female researcher, I found that while these cultural norms significantly impacted the recruitment of my sample among the MSK population (male patients), they had less influence when engaging with health professionals (male physiotherapists). This reflection highlights an important distinction when conducting research in Saudi Arabia.

6.2.3 Sample

The sample size for the qualitative phase was determined based on several considerations. First, the purpose of the sample was not to generalise findings but to gain more in-depth knowledge about each participant's experiences and perspectives (Creswell and Plano Clark 2018), and given this purpose, a smaller sample size often suffices. Some researchers believe that data saturation is a critical consideration in qualitative research (Saunders et al. 2018), as the method plays an integral part in deciding on sample sizes by providing information to researchers when enough information has been gathered for a compelling study.

Data saturation plays an integral role in determining sample sizes for qualitative research, as the method signals when sufficient information has been gathered to construct a compelling study (Guest 2006). Researchers have debated whether that data saturation can be reached and the discussion was triggered by the recognition of the limitations associated with this approach. Though data saturation is widely accepted as a guideline in qualitative research (Morse 2015), the method does present several challenges. A limitation is that determining when saturation has been reached is subjective and can vary among researchers (Saunders et al. 2018). This could impact the consistency and replicability of research results. Despite these considerations, data saturation remains a recommendation in qualitative research (Guest et al. 2006; Morse 2015). Considering the different types of saturation methods, as Saunders et al. (2018) recommended, can enhance the use of saturation as a proper method in qualitative research.

Researchers can adopt four types of data saturation based on their research design and theoretical framework. As Saunders et al. (2018) demonstrated, data saturation informs the researcher when to stop collecting data. This point is reached when no new themes or insights emerge from additional interviews (Guest et al. 2006). This approach views thematic saturation as part of the analysis process, requiring simultaneous interviewing and analysis. Another method depends on reaching theoretical saturation, where collection continues until the findings align with pre-existing theories that guide the study (Saunders et al. 2018). This approach for data saturation was not considered as did not fit with my aim of the current phase.

I utilised the data saturation method, in which saturation occurred during the data collection process; in other words, I continued conducting interviews until similar responses were heard repeatedly (Saunders et al. 2018). This indicates that data saturation occurred during my

method of conducting the interview. Other methods such as thematic or theoretical saturation can be obtained during analysis. This involves interviewing and analysing responses to provide each theme a sufficient amount of data until no new information emerges for each theme (Saunders et al. 2018). While these approaches may produce valuable results, they were not feasible due to time constraints associated with being a PhD student with limited time. Furthermore, my goal was to understand factors limiting patients' and physiotherapists' experiences, and I had conducted a previous survey phase on this topic, achieving early-stage (data collection period) data saturation could provide valuable insights into filling gaps identified by earlier findings. Therefore, considering these factors along with time constraints the decision was made to use an early data saturation approach, as demonstrated by Saunders et al. (2018).

Conducting interviews in Saudi Arabia can prove challenging, as acknowledged by numerous previous studies (Al-Saggaf and Williamson 2004; Adam 2017); discussions are essential to providing more in-depth data collection and an increased understanding of shared experiences between patients and physiotherapists. Therefore, attempts were made to recruit participants and enhance the interview quality. When considering sampling in qualitative research, there are several sampling methods, including purposive sampling and convenience sampling (Etikan et al. 2016). I utilised purposive sampling in the current thesis, this approach allows a more comprehensive representation of participants selected to ensure more representative samples for my population study (Palinkas et al. 2015). Despite its limitations, this approach has proven valuable and enriching (Robinson 2014). Unfortunately, due to cultural norms, I failed to recruit participants through purposive sampling, and convenience sampling had to be utilised instead, as this was related to participants who showed interest and accepted interviews

(Etikan et al. 2016). Although convenience sampling has limitations, valuable data can still be generated, and themes emerged that helped answer the research questions.

The current thesis used purposive, convenience, and self-reflection sampling methods to recruit participants (Robinson 2014; Etikan et al. 2016). Initially, participants were selected based on specific criteria relevant to the research objectives (Palinkas et al. 2015), namely, their overall positive and negative experiences with the use of DHIs. These data were provided in the survey findings, and this selection constituted purposive sampling. I sent invitations to participants asking for their interest in participating in Phase II and considering both genders to enhance the participants' representation to populations. However, as stated previously, only one male patient agreed to be interviewed, and this could limit the participant representation. Therefore, I shifted from purposive sampling to convenience sampling by including those who were readily available and willing to participate. Despite these shifts, the approach and overall selection process still aligned with principles of purposive sampling because the inclusion criteria remained the same (i.e., I continued to seek out individuals' specific experiences under the context of DHI). This combined method allowed me to balance the need for specificity (through initial purposeful selection) and flexibility to adapt when facing practical constraints during the recruitment phase (Etikan et al. 2016).

6.2.4 Interview

Qualitative research employs various methodologies; which one to choose depends on the research question, topic, and theory framework that need to be obtained (Creswell and Poth 2018). If the research aims to examine lived experiences, phenomenology is an ideal method for collecting data; interviews or focus groups are suitable data collection methods (Creswell and Poth 2017). Various qualitative research methods are available for adoption, such as focus

groups, document analysis, observation, and individual interviews (Creswell and Poth 2017). Focus groups can provide valuable collective viewpoints (Fern 2001), but they were impossible due to multiple challenges. Coordinating schedules among working physiotherapists and respecting cultural sensitivities related to gender segregation in Saudi Arabia were among these challenges. While other qualitative methods like observation or document analysis can add valuable insights through methodological triangulation (Patton 2015), ethical considerations around confidentiality within government hospitals made these options unfeasible in the current context. As my study aimed to explore factors that restrict or facilitate DHI usage among MSK patients and physiotherapists; therefore, an individual interview was the best method when considering the aim and the objective (Creswell and Plano Clark 2018).

An interview is one of the most used methods to gain an in-depth understanding of participants' experiences (Brinkmann and Kvale 2015). DiCicco-Bloom and Crabtree (2006) showed the importance of individual interviews for healthcare providers, demonstrating that these one-to-one interactions are particularly useful in gaining comprehensive insights into patients' experiences with their health. Personal interviews allow individuals to express their beliefs and views without feeling judged or influenced by others, as they might be in focus groups. In addition, when considering time, Silverman (2016) stated that available time and resources also play a vital role in decision-making. As a PhD student operating under time constraints, it was also essential for me to select an efficient yet effective method; hence, interviews emerged as the most suitable given all these factors. Despite being time-consuming, one-on-one interviews facilitate a more comprehensive understanding of each participant, as they can express their opinions without being influenced by others (Brinkmann and Kvale 2015). Therefore, when considering research questions within specific contexts, time, and cultures, individual interviews can offer unique opportunities that enhance understanding of MSK patients'

experiences and physiotherapists' perspectives in greater depth, which aligns with my thesis goal.

Regarding qualitative research methods, interview methods offer three approaches for conducting qualitative interviews: structured, unstructured, and semi-structured (Edwards and Holland 2013). Structured interviews entail predetermined questions that the researcher needs to sequentially follow while gathering responses and considering quantitative statistical analysis. Unstructured and semi-structured interviews can be chosen depending on several key considerations within each research objective or topic (Edwards and Holland 2013). One of these considerations is research objectives, which are essential in selecting an interview format. Structured interviews provide quantitative data that is easily comparable between participants (Gill et al. 2008); exploratory studies that seek more profound insight into experiences or phenomena may benefit more from unstructured or semi-structured formats (Brinkmann and Kvale 2015). Second, the nature of the topic being researched is critical. An unstructured approach might be more suitable for sensitive subjects requiring free participant sharing (Elmir et al. 2011), while simple information-gathering tasks could benefit from more structure (Bernard 2005). Thirdly, participant characteristics should be carefully considered. Those expected to contribute may benefit from less construction, while those needing prompts might find difficult questions helpful in sparking dialogue (King and Horrocks 2010). Further consideration must be made of research skills. Conducting and analysing data collected through less-structured interviews requires experienced interviewers who can guide conversations towards research objectives while accurately interpreting responses from respondents (Brinkmann and Kvale 2015).

Similarly, Litchman (2017) demonstrates that the choice among these methods depends primarily on the population under investigation, the nature of the data to be collected, and the subject matter. Regarding the first concept based on Lichtman's insight, the people under investigation were reported previously in previous chapters, both physiotherapists and MSK patients with experiences of using DHI in Saudi Arabia. Regarding the nature of data, this phase aims to explain and provide reasoning for questions that can provide a complete picture of their agreement, such as social influences and the short duration of using DHIs. Regarding the subject matter, which is also highlighted previously but briefly, DHIs are an extensive emergent topic that requires a nuanced understanding not just of medical outcomes but also of using technology; hence, the semi-structured interview can offer comprehensive insights into these matters.

Bryman (2016) demonstrates that semi-structured interviews offer researchers more flexibility when collecting data by allowing them to follow predetermined questions while exploring emerging themes. Predetermined questions provide transparency and replicability for other researchers conducting similar investigations (Bryman 2016). This can be done by utilising UTAUT as an interview question guided by this theory, and cultural factors were considered. Furthermore, using probing and follow-up questions enhances the open questions and provides new insight not previously discovered. Therefore, the flexibility that a semi-structured interview can offer led me to consider this approach as the most suitable for my research design, objective, and theoretical stance. Some researchers argue that utilising semi-structured interviews may have drawbacks. Some researchers may introduce bias by probing into topics they care deeply about, which also happens with unstructured interviews (Fontana and Frey 2000). Researchers use reflexivity to be neutral, enhance the quality of data collected, and recognise any biases or preconceptions they might have during data collection (Berger 2015).

My research approach used mixed methods, utilising two data sets to provide multiple perspectives while strengthening reliability and validity (Creswell and Plano Clark 2007). To effectively meet my research objectives and questions, I used semi-structured interviews, was flexible with data collection, and utilised interview schedules. This is not limited as the participants were asked for more clarification through probing and follow-up questions. While this is effective when considering which approach best provides me with flexibility, the structured interview could be challenging. It might act similarly to the survey data, which will not offer more profound insight into participants' experiences. With the unstructured interview, being open and asking without any guidance, a more profound understanding can be reached. However, it can threaten the consistency and replicability of the research. In addition, as discussed earlier, this can be difficult, as the participants in Saudi Arabia have limited experience with such methods. Conducting interviews without any interview schedule to follow could also be quite challenging. Therefore, several considerations have been made to land on a more appropriate approach for collecting my data and engaging deeper with the participants. As a researcher, I am aware of the suitable method that could lead me to engage more fully with an individual's perception and belief.

While semi-structured interviews are considered time-consuming and incur costs (Adams 2015), Adams acknowledged that researchers could conduct such interviews to fill gaps after the quantitative method analysis and completion. Therefore, the semi-structured interview was selected. Besides Adams's emphasis on the suitability of a semi-structured interview, another researcher highlighted the flexibility of using this method, as researchers can add proper follow-up questions that will enhance the richness and depth of the data that needs to be understood (Gill et al. 2008). The rationale for selecting the interview method was a

consideration of the nature of the mixed methods and their findings, which indicated that further questioning was needed to gain an understanding of why physiotherapists and patients used DHI for short durations (Table 10 and Table 11). This is one example from the determinations in the quantitative phase, and there are many, which can be seen in Chapter 5, guided by the interview schedule in the following sections.

Semi-structured interviews also allow for more freedom when ordering questions (Louise Barriball and While 1994). The interview research schedule was designed for and utilised with all participants to ensure all questions were asked, guaranteeing consistency in findings across participants and enhancing the trustworthiness of the qualitative results (Patton 2015; Bryman 2016). This is also crucial for the researcher, as this approach enables a standardised data analysis when the researcher follows the interview schedule to ensure all participants are asked all the questions, easing comparison of data. Semi-structured interviews offer flexibility by changing the order of questions based on a respondent's answers to specific situations. During the study, some participants shared valuable insights about the obstacles they encountered and the assistance they received from various organisations. The initial question focused on their overall experience. Consequently, I changed the order of questions to facilitate a more natural and fluent interview experience.

6.2.5 Types of interview methods

Various interview formats are available within the literature, including face-to-face (the most popular), telephone, and online methods (such as Zoom). For this study, the online form was chosen primarily due to COVID-19 restrictions, which limited the feasibility of conducting face-to-face interviews. Beyond these constraints, however, there are compelling reasons to consider digital platforms, like Zoom, as potentially more helpful than traditional interview methods. Novick (2008) argued that telephone interviews could yield data as rich as those obtained from face-to-face interactions while offering additional convenience; however, Sturges and Hanrahan (2004) show some differences between these two modes, notably in capturing emotional depth from participants, which they attributed mainly to visual cues available during physical meetings. These findings confirm that while a telephone interview can provide similar in-depth data, it neglects the visual cues and building rapport between the researcher and the participants, which are essential when conducting an interview.

The shift towards technology-driven communication necessitated by COVID-19 has highlighted the potential advantages of using tools like Zoom for qualitative research beyond the pandemic. Archibald et al. (2019) confirmed that using Zoom for qualitative data collection can be effective and provide similar richness compared with traditional interviewing techniques while being cost-effective and enabling access to geographically dispersed participants, thereby enhancing sample representativeness. Most researchers find online methods more convenient due to their ability to reach geographically dispersed populations and lower travel and accommodation costs (Lo Iacono et al. 2016). As a researcher conducting my study in Saudi Arabia and then returning to the UK for various reasons, this feature proved particularly helpful as I continued collecting data while travelling around. Contrast this with

face-to-face interviews that require both parties to be physically present. Scheduling an appointment, booking the venue, and considering other forms of distribution during interview times are necessary to conduct interviews (Irvine et al. 2020). Online interviews proved to be a viable and effective alternative to in-person interviews, allowing for a deeper exploration of participants' experiences and perspectives while offering greater flexibility and adaptability regarding the interview process (Seitz 2016). Archibald et al. (2019) emphasised that non-verbal cue observations, typically associated only with face-to-face interactions, are achievable via video conferencing. Therefore, considering all these factors together suggests that online interviewing may offer significant benefits when conducting qualitative research.

Beyond technological issues such as internet interruptions, building rapport with participants is another essential factor in online interviews. Deakin and Wakefield (2014) found that while establishing rapport in an online setting can differ from face-to-face interactions, this issue was raised by only some participants; some even reported better rapport-building experiences than those encountered during physical interviews. One strategy to enhance participant comfort and facilitate rapport-building involves sending a pre-interview message to the participant. This approach was adopted in my study, as I sent reminder messages before the interview began, asking about their preferred interview time and offering flexibility for changes if needed. However, all participants confirmed their scheduled times without requesting any changes, which may reflect their comfort with this method. The fact that all interviews were conducted as planned further indicates the effectiveness of using digital platforms like Zoom for qualitative data collection. Gray et al. (2020) show the importance of utilising online methods, particularly considering current trends where technology adoption rates are higher than ever, and internet access has become more widespread across developed and developing countries.

While online methods provide many advantages, they also come with some disadvantages that should be noted. One such complication is sampling bias (Portney 2015). Researchers may recruit participants for online studies who are specifically interested in them; this could limit how applicable findings might be across populations. However, in this research study, data collection occurred during a stage of the COVID-19 pandemic when regulations and policies prohibited researchers from conducting physical events like in-person interviews. Therefore, the online interview was the optimal method for resilience and adaptability purposes. Technical issues or internet connectivity problems may interrupt the online interview process, especially in areas with weak internet service (Archibald et al. 2019). However, no such incidents were noted in this study. All participants were instructed to ensure they had an accessible internet connection and a quiet environment to enhance the quality of the interviews. Therefore, while acknowledging the limitations of conducting online interviews, the advantages outweigh these drawbacks. As such, this method is highly recommended for other researchers.

6.2.6 Interview schedule

The interview schedule was developed and discussed with the supervisors to ensure that all the questions related to the quantitative phases were explored. The interview schedule for physiotherapists and patients is attached in **Appendixes XVIII** and **XIX**. Questions were informed by the findings of Phase I and Phase II and started with their general experiences before moving on to their views regarding the difficulties with the DHI, dealing with the self-management and cultural impact of using the DHI, and lastly, their preference regarding using the DHI. The interview schedule was built and discussed with the supervisory team to clarify the questions. To obtain an in-depth understanding of both patients' and physiotherapists' experiences, responses were followed up with further questions (e.g., “What do you mean?”) when appropriate (Turner 2010; Brinkmann and Kvale 2015).

6.2.7 Pilot interview

Interviews were conducted once with each participant, once with the physiotherapist and then once with the patient. I used each interview session to practice interview techniques and get participants' feedback on whether my questions were understood clearly or required more explanation. This step in my research was critical in becoming familiar with Zoom, creating timetables, sending links out, and becoming acquainted with its recording system. Therefore, technical issues were addressed, and the environment where I conducted the interview was thoroughly justified. For enhanced interview quality, a quiet environment was ensured before any interview was started, which is essential to provide more voice clearance for the audio recording. The file for saving these recordings was confirmed at the Cardiff University storage and secured with a password for privacy and confidentiality (McMullin 2023). Awareness of my potential influence and interviewer bias was paramount to avoiding impacting these responses. Promoting consistent behaviour toward all participants by giving enough time for each question served to reduce this bias. For consistency to be maintained during interviews, an interview guide was followed. However, the order of questions was adjusted based on responses to make the interviews more conversational and less rigid. This approach aligns with the recommendation of Irvine (2018), as this approach built participant trust while building rapport during the process. While interview questions for physiotherapists were clear enough to conduct, additional probes needed to understand patient viewpoints were added for patients as a follow-up process. Several factors could explain this; these included Saudi citizens needing to familiarise themselves with interview processes and limited qualitative research in Saudi Arabia. Therefore, as shown above, I included follow-up probes with questions that would

clarify things further for patients. Furthermore, I revised some questions to make them more understandable for all participants.

6.2.8 Transcript

Transcript is the meaning of transferring the audio into word (Duranti 2006), and this process is one of the vital processes in qualitative research and during the writing up, to ensure rigour (McMullin 2023). McMullin (2023) shows the importance of providing a detail, to inform the reader exactly the process of transcription, and as from the previous review, 41 % of researchers did not mention “transcript” in their research. To maintain the rigour of qualitative research, it is important to provide a detailed account of the transcription process (McMullin 2023). I transcribed all Arabic interviews recorded after gathering data by using 'Speech-to-Text' feature in Microsoft Word. To maintain accuracy and prevent misinterpretation of information (McMullin 2023), I listened to each recording again. Utilising such a transcription tool is considered to be cheaper but, as a researcher, I had to be close to the text and fill in any missing words. This process enhances the familiarisation with the data when listening to the recording twice. All of the tools used, including Microsoft Word and Zoom, were authorised by Cardiff University to maintain privacy and safety when using the technology approach for transcriptions. All transcripts were assigned codes for privacy protection while any potential identifier was removed.

6.2.9 Translation

One key component of an interview when translating data for specific audiences is the translation (Squires 2009). Following the guidelines set forth by Squires (2009), as a PhD student studying at Cardiff University, an English-speaking institution in the UK, I undertook

translation duties myself. Admission to such high-ranking universities requires proficiency in English, which assures my capability to translate accurately from Arabic, my native language. All the interviews were conducted in the first language (Arabic); after analysing the interview, I then translated it into English. My cultural background and linguistic skills allowed me to provide accurate translations and capture cultural nuances inherent within participants' responses. Following the guidelines of Squires (2009), it is essential to detail the steps undertaken during translation and discuss advantages and disadvantages. This transparency allows other researchers to evaluate my approach and provides them with a roadmap should they wish to replicate these steps in their studies. I used Microsoft Word for transcription while ensuring accuracy by double-checking each translation. When I needed clarification on specific phrases or expressions during this process, I sought suggestions from bilingual peers. Squires (2009) emphasises that discussing the advantages and disadvantages of one's approach can guide other researchers who are considering similar methods.

The benefits of self-translation include ethical considerations like maintaining participant confidentiality, being closely involved with the accurate data-enhancing representation of cross-cultural experiences, and ensuring cost-effectiveness. However, it does come with potential drawbacks like time consumption due to needing to double-check every translated word and phrase. Despite these challenges, though, given the specific circumstances surrounding this study, including budget constraints and the need to maintain close connection with the data, self-translation emerged as the most suitable option. To create the transcript, I used the Microsoft Translator application in Microsoft Word. At the same time, the Zoom recorder was excellent at sound recording, producing clear and loud vocal recordings compared to face-to-face interviews which may require battery replacement and may have muffled voices due to participants who may sit farther away from the researcher. All these technologies will

prove beneficial to future research endeavours, and my translation is accurate based on data taken during Arabic interviews conducted in this manner.

6.3 Quality of the qualitative research

To ensure rigour and high-quality research, I adhered to the guidelines set forth by Curry and Nunez-Smith (2015). They assert that the quality of any study can be evaluated through four key parameters: veracity, applicability, consistency, and neutrality. Each of these concepts will now be explained in detail for further clarification.

6.3.1 Veracity

Data accuracy and honesty of information in qualitative research refer to veracity (Curry and Nunez-Smith 2015). Integrity plays an essential role in research, ensuring that collected and analysed information is reliable and valid, and has long been an issue in healthcare and social sciences. In addition, the accuracy of patient data is essential to providing appropriate and effective care (Liu 2014). As in social science research, clinical trial research must ensure that its data accurately reflect the experiences and views of the populations under investigation (Creswell 2003). Researchers can employ various techniques to ensure veracity in their research, including validating data through multiple sources, triangulating results, and member checking. To enhance the credibility of my current data, I utilised various sources, interviews and surveys, which increased its credibility (Yin 2018).

When it comes to enhancing the accuracy of qualitative research, it is often mentioned that the availability of member checks can improve veracity. In the current study, member checks as an institution review were not feasible. However, I used member checking to receive participant

feedback (Thomas 2016); such member checks could also strengthen the credibility and validity of findings (Lo 2014). This allows participants to review and comment on collected data to ensure their views are accurately captured (Kornbluh 2015). Researchers assert that these techniques may provide a worthwhile means of improving data quality (Lo 2014; Kornbluh 2015); however, this strategy may also have certain potential drawbacks, and conflict has risen over whether member checks could enhance the accuracy of the research (Thomas 2017). Despite this conflict, I employed member checking as a form of participant feedback, sharing the transcripts to confirm their accuracy. However, this approach proved time-consuming as it required waiting for participants' responses, which ultimately did not result in any changes to the original transcripts (Birt et al. 2016). Thomas (2017) has shown that despite its widespread use, member checking, particularly participant feedback, does not necessarily guarantee validity within research. Therefore, I further ensured accuracy by triangulating data across three phases; the discussion chapter will provide details about this process.

Utilising multiple data sources is one way to strengthen qualitative research (Yin 2018), yet practical constraints prevent me from tapping these sources of information, as stated previously. However, employing two complementary data collection methods (surveys and interviews) helped increase the qualitative phase's credibility. By triangulating survey and interview data, this study was able to gain a complete understanding of complex topics, with surveys providing breadth while interviews added more depth (Creswell and Clark 2018). This approach follows best practices in mixed methods research that emphasises using multiple methodologies to increase the validity and reliability of findings. Credibility was further increased by engaging two experienced researchers to examine theme coding and development (Nowell et al. 2017). I also accomplished this by scheduling regular meetings with my supervisors to discuss coding steps as part of thematic analysis (Nowell et al. 2017).

6.3.2 Applicability

Applicability refers to whether research findings can be applied across groups or settings (Curry and Nunez-Smith 2015) or be relevant or applicable in other contexts with similar circumstances, demographics, and occurrences (Leung 2015). The applicability of research findings across different settings and contexts can be significantly enhanced by considering several key factors. These include understanding the cultural context and acknowledging variations in healthcare systems (Renjith et al. 2021). The introduction provides insights into these aspects, making it easier for other researchers or organisations, particularly those operating within similar religions and cultures, such as Arabic countries, to understand the work's relevance. Even societies with diverse cultures could find value from this approach due to increasing multiculturalism worldwide; Kottak and Kozaitis (2011) have highlighted how understanding these differences benefits nations.

Furthermore, shared global experiences like the COVID-19 pandemic enhance the study findings' applicability since the pandemic's impact has been universally felt across all nations. For instance, restrictions imposed during 2020 and in early 2021 were common globally; similarly, shifting towards digital healthcare was a universal trend observed during this period (Peek et al. 2020). The study design and interview schedules were also based on scoping review principles. The usage of the UTAUT model is explained thoroughly so interested researchers can understand and adapt it efficiently, thus furthering potential applications.

6.3.3 Consistency

Regarding consistency or dependability, Elo et al. (2014) and Cypress (2017) have defined dependability in research as the consistency of findings replicable by other researchers.

Consistency was ensured in this study by reviewing and discussing the data interpretation with supervisors; through these discussions, codes, subthemes, and themes were further refined throughout the qualitative data analysis. Consistency is often related to qualitative research and other reported dependability and reliability factors for quantitative or mixed-methods research. As stated, in quantitative research, reliability means the ability to repeat a measure and produce similar data when repeated. In qualitative research, perfect repetition seems challenging (Bryman 2016). As many aspects are related to qualitative research, the possible approach for conducting this is to evaluate the entire process of the researcher. This can be done by having the researcher report every step before starting the research. Therefore, reflexivity is critical, as it yields the research belief and possible prior assumptions, background information, reason for selecting the topic, research design, methods, analysis, and findings reporting.

6.3.4 Neutrality

Neutrality refers to any prior assumptions by researchers that could skew the analysis or interpretation of findings (Curry and Nunez-Smith 2015). Connelly (2016) noted that researchers should write each data analysis step to help confirm research findings. In addition, qualitative confirmability can be achieved by reflecting on assumptions (Curry and Nunez-Smith 2015); these reflexive assumptions are written down using reflexivity in mixed-methods research projects to maintain neutrality. Confirmability can be evaluated by reviewing all the processes of the researcher and the associated confidence. The consistency of the thesis can be evaluated by providing a rationale for the topic, which is an important area to explore, and the COVID-19 lockdown and restrictions confirm this. In addition, Saudi Vision 2030 was the second factor that provided a rationale for introducing the importance of digitalisation and healthcare's shift to digital life. Furthermore, DHI and MSK condition are complex topics that cannot be understood by one type of method and provide a rationale for selecting the mixed methods design. The method for scoping review, the quantitative Phase I and the qualitative

Phase II, are described in detail to help another researcher understand the process, enhancing consistency and leading to more applicable results for similar contexts. Thematic analysis and reflexivity are described in the following sections.

6.3.5 Reflexivity

Reflexivity is a self-evaluation and reflection process examining any impact that the researcher's personal history or perspective could have on the research process and findings (Ben-Ari and Enosh 2010). Using diaries during the research process has been proven effective at identifying personal bias and devising ways of combatting it (Ortlipp 2008). I keep diaries detailing every project stage, meeting minutes with supervisors, and reflective notes; such records can prove immensely helpful for reflexivity. I will highlight several critical aspects of reflexivity that assist in recognising and addressing my pre-existing assumptions. Researchers assert that the interpretation of findings is adversely impacted by prior beliefs and experiences since these cannot be separated from a researcher's mind (Creswell and Miller 2000; Johnson et al. 2020). Johnson et al. (2020) demonstrate the potential influence of a researcher's personal beliefs, background and experiences during data interpretation. However, awareness of its effect is the first step towards moving away from personal interpretation and letting data speak for itself to capture participant voices accurately (Finlay and Gough 2003). Reflexive writing helps others to recognise the trustworthiness of the result and the credibility of the findings. Reflecting on my beliefs, my assumptions before starting my research, and my background helps to identify the pattern of interpreting the findings and shapes the outcome of the result based on my position.

My research background primarily consisted of quantitative methods, and I had minimal exposure to qualitative research. When undertaking a mixed-methods approach for this thesis', it was essential to reflect on the potential impact of my lack of experience with qualitative studies to minimise personal bias and address weaknesses often associated with mixed-methods research, where research might favour one method over another. I spent less time on quantitative analysis during the investigation since it was mainly descriptive and straightforward compared to the more involved process required to analyse qualitative data. Despite these limitations, I maintained the balance between both types of data. Integrating multiple methods allowed me to enhance the validity and trustworthiness of the thesis's findings by providing complementary perspectives from both quantitative and qualitative approaches. This ultimately strengthened my understanding of the DHI while minimising potential biases from relying solely on either method alone. Also, I took several courses in qualitative research methods, which equipped me with the necessary skills for conducting interviews, analysing data, and interpreting findings using thematic analysis.

Quantitative research involves testing hypotheses using statistical analysis, making them more generalised for a specific population (Portney and Watkins 2013). The researcher often looks to measurements such as pain, range of motion, physical and functional activity, and strength of movement. These measurements are typically quantifiable and, therefore, lead to a quantitative research method. Research has recently shifted to qualitative research, which can give more in-depth data on patients' experiences, which is difficult to capture by quantitative analysis. Upon first reviewing the literature, I believed that I did not need to reflect upon my position when conducting a quantitative study, as many studies emphasised the significance of reflexivity for qualitative research (Lazard and McAvoy 2020; Olukotun et al. 2021). Reading qualitative studies led me to believe that reflexivity was not essential for quantitative analysis,

given its emphasis on numerical data and statistical measures. This led me to assume that my role as a researcher would have minimal bearing on survey findings.

However, my belief shifted as further reading revealed how reflexivity goes beyond the data collection and analysis phases; it also encompasses decisions regarding selecting research questions and methods (Ryan and Golden 2006). Jamieson et al. (2023) confirmed that and highlighted the importance of reflexivity for quantitative research. Based on this understanding, I recognised my assumptions were essential at various stages: when formulating the research question through an extensive scoping review, when choosing the UTAUT model as a theoretical foundation, and when including cultural aspects in my study design. By doing this, potential bias can be avoided and provide comprehensive information to readers so they know to be aware of my prior assumption and background and, therefore, can fully understand and evaluate my possible impact on overall findings and conclusions (Attride-Stirling 2001).

As a Saudi researcher investigating a DHI in Saudi Arabia, my background and previous experiences could influence my perceptions and interpretations of the data. While I am a Saudi national, I have limited experience working in the digital health field, and the DHI being studied is new to the Saudi context. I took several steps to engage in reflexivity throughout the research process to address this potential bias. I acknowledged my limited experience in the DHI. As I started my PhD journey, I sought to expand my understanding through extensive searching of the literature by doing a scoping review and having regular consultations with supervisors who are experts in the field. I have also attended conferences and seminars and presented in the journal club to better understand the digital health field.

This is also acknowledged before and during the data collection. Before the data collection, I recognised the impact of the COVID-19 pandemic on the shift towards digital learning and remote consultation. As a result of the pandemic, many traditional face-to-face learning experiences have been disrupted, and digital platforms have become increasingly important. Thus, my research in the digital health field may have been influenced by external factors such as the pandemic. Being from Saudi Arabia influenced my understanding or interpretation of data collected from participants who are also Saudis. For instance, shared cultural norms led me to interpret specific responses differently than an outsider would. Initially, I had preconceived notions that DHI was not widely used within Saudi Arabia, as no published research indicates significant interest in the use of DHI.

Unawareness of the benefits of DHI may be a factor preventing patients and physiotherapists alike from making use of it in Saudi Arabia. Furthermore, patient preferences might play a part in Saudi Arabia, as gender segregation might limit access. These assumptions influenced my approach to interviews and data analysis. Reviewing interview schedule questions and making necessary alterations to avoid leading questions would reduce potential bias during schedule creation. For example, some questions were created with Saudi Arabian societal norms in mind; I asked participants if they had noticed any cultural barriers when using DHI, providing an opportunity for them to articulate any specific factors that have hindered or promoted its usage. The culture was undoubtedly influenced due to Saudi Arabian societal norms such as gender roles and lack of family support.

I utilised a manifest coding approach, which is objective in nature, and employed both inductive and deductive approaches to ensure the balance between subjectivity and objectivity. This helped confirm that my analysis was not purely subjective as it would be with an

exclusively inductive approach, nor entirely objective as with a solely deductive one. My previous experiences conducting quantitative research helped me maintain this neutral position, neither fully embracing the subjectivity inherent to qualitative research nor opting for the strict objectiveness associated with quantitative methods. My analytical abilities were improved through the act of balancing, which has helped me in implementing a mixed-methods approach. I am mindful of my assumption that regular meetings with supervisors provided a broad opportunity for discussing every stage of my project until reaching a conclusion. This reflexive process taught me the significance of acknowledging personal biases when conducting quantitative and qualitative studies, which is the current nature of my study.

6.4 Impact of COVID-19

I began my PhD studies just two months before the beginning of the COVID-19 pandemic, which significantly impacted my ability to engage with my research. The early stages of a PhD study require substantial engagement with supervisors and fellow postgraduate research students, an aspect that was disrupted due to COVID-19 restrictions. Despite these challenges, numerous online events have been conducted up until now, which positively influenced my engagement with the study and enhanced my understanding of various aspects, such as research methodologies, ethics in conducting studies, academic writing skills, and even preparation for viva voce examinations. During this period, I returned to my home country, where I productively utilised lockdown periods by conducting scoping reviews, tasks that did not necessitate leaving home or physical interaction but required extensive reading of articles related to fieldwork. I also made changes at home that were conducive to studying by creating a space dedicated to storing books and papers and setting up an appropriate desk to facilitate focused work hours. The lockdown taught me valuable lessons on adaptability during unprecedented times like these.

Before I began my PhD studies and at the end of my master's degree program, my mother was diagnosed with lung cancer. This period became particularly challenging due to her compromised health condition and the subsequent spread of COVID-19. My worries were further compounded when she, my daughter, and I contracted the virus. Despite these hardships, I managed to pull through; every moment from that difficult time remains etched in my memory. The lockdown had negative impacts, such as loss of face-to-face engagement with supervisors and fellow PGR students, affecting collaborative learning experiences, and positive impacts by providing valuable insights into DHIs for self-management among MSK patients and physiotherapists, an area directly related to my research topic. These factors were rapidly utilised during this period, providing valuable perspectives for researchers interested in digital interventions. COVID-19 also impacted my data collection plans: Initially, I planned to conduct scoping reviews to identify gaps, followed by fieldwork in the UK, but due to the pandemic restrictions, I had to change my plans, shifting data collection efforts towards Saudi Arabia.

6.5 Data analysis

Reporting on the analysis process is essential in helping other researchers appreciate how applicable and transferable the findings are to their environment, and transferability could also be achieved by documenting each step of the data analysis to maintain neutrality. Several tools can help the researcher manage their data and enhance the organisation of the data sets. NVivo 12 is a tool that assists researchers in managing data, particularly qualitative data. However, I needed to utilise the tool from the onset of my data analysis process. I transcribed the recordings in Microsoft Word while reading and listening to them multiple times. The initial coding process was started in Microsoft Word, with individual documents created for each participant.

This initial step proved beneficial as it allowed me to familiarise myself with the content before managing the data using NVivo.

6.5.1 Thematic analysis

Several methods can be used to analyse qualitative data: thematic analysis, interpretative phenomenological analysis, grounded theory, and framework analysis. Braun and Clarke (2006) describe thematic analysis as an indispensable data analysis technique used by qualitative researchers. The most common qualitative method is thematic analysis (Roulston 2001), and Braun and Clarke (2006) call this a foundational method. Thematic analysis can be defined as the process of identifying possible themes or patterns in qualitative data. The analysis undertaken for the qualitative phase was a thematic analysis; multiple reasons led to the choice of this type of analysis. The primary reason is flexibility, as thematic analysis is a straightforward process that can be conducted with various research questions and even with different epistemological backgrounds. As the aim is to identify the experiences and factors that hinder both groups of participants by looking at the data set, identifying the pattern, and providing a valuable answer to the research questions, thematic analysis was found to be the best method for this study. The analysis process reported here makes the data vital and allows other researchers to identify the similarities and differences (Braun and Clarke 2019).

As part of my approach, I utilised deductive and inductive reasoning techniques, using UTAUT as my theoretical framework and inductive analysis techniques to identify relevant themes that would enhance findings and increase data comprehension. This was followed by a discussion amongst the supervision team to establish the groupings for all of the codes used, uncover all similarities, and begin categorising. As part of the subsequent steps, categories were combined into themes, with revisions made to all of them before the end stages to create the final themes.

This step was undertaken for both groups. However, this study combined deductive and inductive analysis methods to identify barriers and facilitators associated with adopting DHI as a self-management approach. Although the UTAUT theoretical framework may seem more suitable as an analytical starting point, this was used more as an initial guide rather than for rigidly outlining all codes or themes before starting the reading. Utilising existing theories does not prevent iterative processes from being employed where new themes can surface via the induction approach.

Further, regarding the deductive and inductive approaches, breaking down the transcript into smaller parts (Braun and Clarke 2006) can be done by utilising code. Code can be defined as a labelled short phrase or a word meant to capture a feature of the data per the interest of the researcher (Saldana 2015). Two coding forms exist, manifest and latent (Graneheim and Lundman 2004), depending on the nature of the research. Semantic coding is an objective method that emphasises observable content within data, with less emphasis placed on interpretation than on what participants have directly stated. I coded using this approach for two main reasons. First, utilising semantic codes ensures that results from cross-sectional cultural research, such as in this study, remain grounded within the original data rather than within interpretations made by researchers that may not be understandable to other populations due to cultural differences. While semantic coding reduces subjectivity compared to latent codes, researchers' influence can still affect data analysis because my decision of which codes, categories, or themes best represent data will inevitably have an effect. However, several steps have been undertaken to avoid bias, which was reported in the previous sections. Therefore, the aim to provide rigour during and after data analysis can be ensured by considering these measurements.

My second rationale for choosing semantic coding lies within my research design. As I plan to describe experiences comprehensively as they naturally unfold (Polit and Beck 2010), semantic coding is an ideal method (Polit and Beck 2010). Semantic coding is objective and involves categorising data (Graneheim and Lundman 2004). In contrast, latent coding involves deciphering meanings and themes within data that may not be immediately obvious to a researcher; hence, such an approach will be more suitable for grounded theory (Charmaz 2006) or phenomenology (Moustakas 2004). Therefore, using the semantic coding approach, the researcher enhances the processability of the data and its applicability and transferability. This would help other researchers find the current results more readily applicable in their context.

Braun and Clarke (2019) provide six steps I followed to analyse the transcript and provide in-depth data for the discussion chapter. I began by familiarising myself with the transcript and initiating the initial coding of its contents. As the analysis began when I was starting the data collection, as stated during the transcript, I read and reread the transcript to become familiar with the data. Familiarisation with the data was the first step undertaken as I transcribed all the interviews and revised all the audio recordings. Therefore, I became more familiar with the data and the transcripts were read several times. Furthermore, the analysis was made in the Arabic Language as I am a native Arabic speaker and all of the participants spoke Arabic during the interviews; therefore, it was essential to analyse the data in Arabic. By analysing the data in Arabic, I ensured that nuances and subtleties inherent to the language were preserved during translation (Squires 2009). This approach maintains cultural specificity that could be misinterpreted if translated into another language (Temple and Young 2014). Furthermore, it has been revealed by Esposito (2001) that analysing participants' native languages helps researchers stay closer to the participants' lived experiences as expressed through their own words.

After generating the initial code, I met with my supervisors to discuss all the coding and label the codes into categories. The categories are the grouping of similar codes under one considerable group. At this stage of the research process, I began coding using predefined codes as a starting point. However, I did not limit myself to these initial codes; my objective was to identify factors that either facilitated or impeded participant engagement with DHIs. Additionally, I sought new data that could offer unique insights into the challenges physiotherapists and patients face. For example, as I was conducting my study in a country with a compassionate culture, I initially categorised the lack of time to use DHI due to home responsibilities as 'Time Constraints' under the more general sub-theme 'Lack of Supportive Home Environment'. However, further analysis showed that gender roles could influence patients' engagement with DHI services. I integrated cultural insights into my discussion by integrating previous findings (Phase I and the scoping review) to reduce potential bias and avoid overlooking cultural barriers that could inadvertently alter my findings. As a researcher, I must recognise cultural factors based on prior assumptions; even though participant voices and responses were coded as manifest codes, cultural factors still indirectly influence the process of coding, underscoring their significance within this specific context.

What is notable is my approach of not dismissing predefined codes from my prior findings (the scoping review and survey data). Achieving the balance between inductive and deductive analysis enhanced my ability to capture the current use of DHI and the factors limiting its success among participants. Pragmatism takes an iterative approach to problem-solving by first identifying issues, then grouping similar codes under broad categories before, finally, consolidating all subthemes under themes (Tables 12, 13, 14, 15). This process can be seen in the table provided. At the forefront of analysis was delineating a theme and setting research

objectives, taking both into account during categorising and coding processes. As part of my research process and considering the research objective, I aimed to minimise my impact and enhance the confirmability of findings. After developing four themes, each defined and supported with quotations in **Chapter 7**, they were finally established as definitive findings.

6.6 Ethical considerations

This is similar to the ethical approval received in the quantitative phases (Chapter 4), as I received the approval once for both phases. All relevant documents are in the appendix (Appendix III, IV, V). The invitation was sent to the participants, the patients who agreed to take part in the second phase, and for those who agreed to take part, an information sheet for the interview, for physiotherapists (Appendix IX), and for patients (Appendix XV) were sent to them, followed by consent form for physiotherapist (Appendix VII), and for patients (Appendix XVII). All of the participants' files were anonymised using research codes which included no names. Participants were informed that they could withdraw from the study without giving a reason and that this would not affect their medical treatment. Confidentiality of the data was maintained throughout the study, and so was the case with the anonymity of participants' information in the data analysis or the results. In addition, any participant who requested a summary of the findings was provided one, which was sent through WhatsApp or email.

All ethical issues were considered during recruitment, data collection, and analysis. An information sheet and consent form were developed and translated into Arabic to clarify information for a patient who could not understand English, as the research was conducted in Saudi Arabia, where Arabic was the primary spoken language. All participants were informed that they could cease their involvement in the study without explaining why and without

affecting their relationship with the researcher. Moreover, participants were provided with details about how their answers would be used and how their information would be kept confidential and anonymous. Due to the online nature of this project, no physical contact with the participants occurred. Eye strain might have occurred due to the usage of a digital device, but this was unlikely because of the relatively short duration. However, the researcher advised participants to take breaks from the digital device if necessary (Coles-Bernnan 2019). In addition, if participants had any doubts or anxieties about using a DHI that may have emerged from the nature of the study, the participants were referred back to their perspective physiotherapist (if the participant was a patient) or line manager (if the participant was a physiotherapist) based on the NICE guideline for managing generalised anxiety (2019).

Furthermore, participants were provided with relevant information regarding their health and well-being, especially during the COVID-19 pandemic. All participants were informed to notify the researcher if they felt unwell or uncomfortable during the interview. Thus, I was able to provide support for the participants and notify them that the data collection process could be stopped and rescheduled if necessary (Dickson-Swift et al. 2008; Mitchell and Irvine 2008). Patients were informed that their usual care would be continued after exploring the current care and that their participation in the study would not impact clinical care or clinical practice. Finally, the findings of this study were shared with participants who wished to understand the factors that might impact their acceptance of and interactions with technology in clinical practice to enhance the quality of healthcare services.

When conducting online studies, ethical considerations are crucial. Braun and Clarke (2019) highlighted the importance of protecting the privacy and confidentiality of participants during online research. In this study, ethical considerations were addressed before data collection

began. The Cardiff University ethical committee and the Ministry of Health in Saudi Arabia reviewed and approved proceeding with the data collection. In addition, all the participants were provided with a transparent information sheet with detailed information about the nature of the study and data protection, privacy, and confidentiality. Thus, through these approaches, the ethical considerations were met, and the limitation regarding the online study could be avoided.

Chapter 7

Qualitative Findings

Chapter 7: Qualitative Findings (Semi-structured interview)

Findings (Phase II)

7. Result

This chapter investigates patients' and physiotherapists' experiences of using DHI in Saudi Arabia. Semi-structured online interviews were conducted to understand physiotherapists' and patients' views. The aim was,

- To identify and understand barriers and facilitators to the recommendation and use of DHI by MSK physiotherapists.
- To identify and understand barriers and facilitators to the acceptance and use of DHI by MSK patients.
- To formulate recommendations to provide guidance and improve the utilisation of DHI in treating MSK patients by physiotherapists

7.1 Demographic data for the participants

The participants in the current phase were selected from **Phase I** of the survey. **Table 13** outlines the demographic data for physiotherapists, including their years of practice experience. Conversely, **Table 14** provides comparable information for the patients with additional details regarding their specific conditions. To maintain participant confidentiality and align with survey presentation methods, both their age and years of experience are presented as ranges.

Table 14: Demographic data for physiotherapists.

Physiotherapists	Gender	Age range	Education	Work experiences
PT1	Female	25-35 years	Bachelor's	0-5 years
PT2	Male	36-45 years	Master's	10-20 years
PT3	Female	25-35 years	Bachelor's	0-5 years
PT4	Male	36-45 years	Bachelor's	5-9 years
PT5	Female	25-35 years	Bachelor's	0-5 years
PT6	Male	25-35 years	Master's	5-9 years
PT7	Male	36-45 years	Bachelor's	5-9 years
PT8	Female	36-45 years	Bachelor's	10-20 years
PT9	Male	36-45 years	Bachelor's	5-9 years
PT10	Female	25-35 years	Bachelor's	0-5 years
PT11	Male	25-35 years	Bachelor's	5-9 years

Table 15 16: Demographic data for patients with musculoskeletal conditions

Patients	Gender	Age range	Education	Condition
pt1	Female	36-45 years	Bachelor's	Shoulder pain
pt2	Female	18-25 years	Bachelor's	LBP
pt3	Male	26-35 years	Bachelor's	ACL
pt4	Female	26-35 years	Bachelor's	LBP
pt5	Female	36-45 years	High school	Knee OA
pt6	Female	26-35 years	Bachelor's	Wrist pain, previous fracture
pt7	Female	>56 years	High school	Knee OA and LBP

7.2 Data familiarisation, coding and the process of developing themes

Before developing themes, researchers should become acquainted with their data (in this instance, transcripts) (Braun and Clark 2019). This involves reading and rereading each transcript several times until familiarity has been attained. Once familiarity has been achieved, initial codes are then generated. Coding is a method for categorising or labelling data based on its meaning or significance, helping identify patterns and similarities across my dataset (Table 14/15/16/17). Subthemes are then developed by grouping codes that share similar meanings or concepts together to form subthemes and then be organised into larger overarching themes that capture some level of pattern within the dataset and are presented in tabular form for ease of understanding (Table 16). In addition, the data were saturated after interviewing seven patients and 11 physiotherapists.

Table 17: Theme1: The use of DHI to support MSK rehabilitation.

Code	Categories	Sub-theme
• Safety measures • COVID-19 restrictions • Reduce patient attendance. • Disruption of face-to-face session	Impact of COVID-19	Lack of access to the physiotherapy department
• Unviability of traditional session	Appointment constraints	
• Limited appointments		
• Enhance the recall of the treatment. • Assistance tool • Personalised treatment • Monitoring patient's progress	Enhancing patient's experiences	Flexible use of technology
• Enhance patient-provider relationship		
• Personalised care	Empowerment patient through DHI	
• Patient education		
• Using DHI as a multimedia for providing instruction about the exercise		
• Maintain continuity of patient's care	Maintaining high standards of care	Organisational requirement
• Digitalisation on the delivery of the healthcare	Digital transformation (Vision of 2030)	Adapting to change
• Digital evolution		

Table 18: Theme2: Barriers of using digital health interventions.

Patients' perspective			
• Preference of alternative treatment • Human interaction seems essential. • Prefer paper-based treatment.	Alternative treatment preference		Prefer other treatment
• Feeling more confident with face-to-face session • Better commitment • Perceived lack of connection • Assurance from face-to-face session	Emotional factor		
• Lack of motivation from DHI • Digital literacy	Resistance to Digital transition		
• Lack of family support • Limited availability of external support	Insufficient support		Lack of external support
• Availability of equipment at home • Limited space at home	Physical challenges		Lack of supportive home environment
• Distraction and interruptions at home • Family and household responsibility • Time constraints	Challenges and competing demand at home		
• Perception of pain as a barrier	Pain-related barriers		Patient's condition
• Fear of worsening pain			
Physiotherapists' perspective			
• Pressure to meet statistics	Performance pressure		Policy changes
• Potential for mistake	Rapid implementation		
• Faster Imposed due to COVID			
• Inadequate support from organisation • Lack of peer support • Need for guidance. • Lack of communication training • Lack of resources	Insufficient organisational support		Lack of support
• Better interaction during face-to-face session • Direct patient assessment	Challenges in caring remotely		Preference for face-to-face session
• Low level of health literacy • Lack of digital literacy	Educational influences		Patient's characteristics
• Patient not willingness to take responsibilities. • Lack of accept to use technology. • Resistance to change.	Patient attitude towards DHI		
• Severity of conditions • Additional health conditions	Condition specific factors		
• Discomfort with technology • Language barriers	Cultural and linguistic differences		Cultural factors

Table 19: Theme3: Facilitators of using digital health interventions.

Patients' perspective		
Positive patient physiotherapist interaction	Role of healthcare provider	External support
Family support	Role of family	
Reduce travel cost	Accessibility	Environmental facilitators
Timesaving	Convenience	
Physiotherapists' perspective		
Patient motivation	Patient willingness	Patient characteristic
Confidence in self-efficacy		
More efficient use of time	Job factors	Perceived effectiveness
Job satisfaction enhanced		
Patient's trust increased	Patient factors	
Quick communication with patient	Efficient interaction	Flexible of the communication
Convenient communication		
Depend on patients	External factor	Preference for blended approach
Required both approach		
Prefer both faces to face and digital way	Internal factor	
Adapting to culture norms	Respect of gender sensitivity	Cultural factor
Respect for Gender norms		
Availability of multiple communication options to overcome cultural barrier	providing communication flexibility	
- Barriers related to geographical area. - Patient lived distance from hospital	Geographical barriers	Environmental factor

Table 20: Theme 4: Ways to boost the recommendation.

• Seeking workshops • Addressing communication challenges • Need for training. • Perceived simplicity of the DHI • Need to build trust. • Addressing patient concerns • Providing reassurance • Difficult using DHI at the beginning	Training for physiotherapist	Support from the organisation
• Providing guidance and support • Need for basic, practical guidance for effective way to communicate through digital way. • Standardization of DHI usage • Clear regulations and rules	Guideline	
• Reduce pressure to meet the statistics. • Flexible scheduling	Promote flexibility	
• Sharing experiences among colleagues • Encouraging teamwork	Colleagues' support	
• Visualisation of functional movement • Utilisation WhatsApp, as alternative communication method to reduce technical issues. • Flexibility in DHI • Providing patient feedback • Promoting adoption of DHI	Integration of different technology Providing patient's experiences	Expansion in the DHIs
• Need of advertising for DHI • Patient's unawareness of these services	Way to increase patient awareness	Enhance patient's awareness to increase acceptance
• Security concerns should address. • Patient trust • Importance of the communication	Factors influence on patient's acceptance	

Table 21: Themes and subthemes emerged from the qualitative data.

Theme	Subtheme				
The use of DHI to support MSK rehabilitation	Lack of access to the physiotherapy department	Flexible use of technology		Organisational requirement	Adapting to change
Barrier to using DHIs from patients' and physiotherapists' perspectives					
• Patient's perspective	Prefer face to face treatment	Lack of external support	Lack of supportive home environment	Patient's conditions	
• Physiotherapist's perspective	Policy changes	Lack of training and resources	Lack of peer support	Patient's characteristics	Cultural factors
Facilitator to use DHI from patients' and physiotherapists' perspectives					
• Patient's perspective	External support	Environmental facilitators			
• Patient's perspective	Patient's characteristic	Perceived effectiveness	communications	Cultural factors	Environmental factors
Ways to boost the recommendation.	Support from the organisation	Expansion in the DHIs		Enhance patient's awareness to increase acceptance	

7.3 Findings

The qualitative interviews were analysed in-depth and patterns in the data were identified using thematic analysis (Braun and Clarke 2006). Four main themes were identified.

- The use of DHIs to support MSK rehabilitation.
- Barriers to using DHIs from patients' and physiotherapists' perspectives.
- Facilitators for using DHIs from patients' and physiotherapists' perspectives.
- Ways to boost the recommendation of DHIs from physiotherapists' perspectives.

7.3.1 The use of DHI to support MSK rehabilitation.

7.3.1.1 Lack of access to the physiotherapy department

Digital Health Interventions were recommended by all physiotherapists and utilised by patients primarily due to challenges posed by the COVID-19 pandemic. The restrictions and safety measures implemented during this period significantly limited access to in-person services at physiotherapy departments in Saudi Arabia, thus leading both physiotherapists and MSK patients towards adopting these digital tools.

“Due to COVID, patients faced difficulties attending the clinic. We started with some patients who could use them; digital health interventions are unsuitable for all patients”. (PT6)

“First, of course, the pandemic prevented us from seeing patients”. (PT11)

“The COVID-19 pandemic, which made it necessary to reduce the number of patients”. (PT 4)

One patient started using the online application and communicating digitally due to unavailability of an appointment; thus, the patient was being monitored through the application once a week.

“I used to go to the hospital twice a week, but when the sessions were interrupted, and there were no appointments, she (physiotherapist) told me to contact her through the online application (Sehhaty)”. (pt.6)

7.3.1.2 Flexible use of technology

Participants indicated that DHIs can be used flexibly depending on patient need, and support.

The most common reason after the pandemic was to act as a reminder of the treatment plan and exercise for patients to use in their homes.

“I gave him (patient) treatment methods with videos or pictures, which he didn't understand how to do them or did not fully remember all the treatments. I gave him the number of repetitions and sets for each exercise and let him do it at home”. (PT2)

“Some therapists used application as an alternative to the face-face session, especially during the pandemic, but honestly, I did not use it as an alternative; I used it as an assistant and most of all as an education for the patient”. (PT 8)

In addition, the flexibility of use of DHI allowed patients and physiotherapists to keep in contact at various hours, unbounded by the time and physical restrictions of a face-to-face session at the clinic.

“Thing is that the patient, no matter how much improvement they have achieved, will see that you have done a great job with him, and you have given them your time, sent them exercises and worked with him during non-working hours. Sometimes people talk to you at nine or ten o'clock at night. You communicate with them, and you respond according to your availability. That's the most notable thing I see”. (PT2)

“I was telling them that they could communicate with me on telegram and give me the file number and indicate whether they had symptoms after the exercises or the session, I always told them to inform me about it on Telegram (Real time mobile application), and we would see if they got better”. (PT10)

7.3.1.3 Empowering patients through support tools

A concern about the use of DHI expressed by the physiotherapists was that the patient might do the exercises in the wrong way, which could be addressed by providing the correct techniques with videos and pictures. In addition, DHI was provided as an empowerment approach to provide support for the patient and to ensure engagement in their treatment.

“She asked me about the exercises and sent me pictures of them. She saw how I applied them, how they affected me and so on”. (pt.2)

“First of all, all the patients that I have are sent pictures and videos of the exercises instead of paper instructions, because the patients can see the exercises better movement than the pictures, learn the right technique and figure out how to do the exercise”. (PT10)

The physiotherapist was concerned not only with the wrong movement that patients may perform but also with the correct execution of the exercise techniques using the videos and the pictures in front of them.

“To know the right technique, do the exercise and see the photos and video in front of him”. (PT11)

Another physiotherapist stated that DHIs were recommended to reduce the number of face-to-face treatments to allow patients to become responsible for themselves.

“I reduced the number of face-to-face sessions because I wanted them to depend on themselves. It gave them a greater sense of the importance of being responsible for themselves”. (PT5)

7.3.1.4 Organisational requirement

While the use of DHI is mandated across all hospitals, responses from physiotherapists regarding their adoption varied. The physiotherapists confirmed that organisational requirements were a significant factor in their recommendation of DHI. Specifically, seven out of eleven indicated hospital mandates as being their primary motivation for delivering DHI and

highlight how institutional directives play a crucial role in shaping physiotherapists' attitudes and practice towards these interventions.

“We are required to provide additional online sessions to some existing patients. If we decide that they do not need to attend face-to-face sessions in the hospital after the first assessment, we contact them later through the mobile application”. (PT9)

7.3.1.5 Adapting to change

Physiotherapists have recognised that considering the world's rapid transition towards digitisation, they must evolve their practices accordingly. As society increasingly embraces digital solutions across various sectors, healthcare services also need to align with these changes by integrating technologies into regular practice. Therefore, they stated that physiotherapists need to adapt to these changes.

“Everything in the world now has become digital. We have to keep up with the times, artificial intelligence and these things”. (PT7)

Digital health intervention is used extensively to support MSK rehabilitation in various ways, and these aspects underline its value. These include overcoming barriers such as limited access to physiotherapy departments due to COVID-19 regulations and appointment unavailability. Technology is essential in patient-specific adaptations and communication outside traditional hours between physiotherapists and patients. Additionally, DHIs can empower patients by offering treatment plans, exercise reminders and supportive tools. Organisational requirements provide another effective view for adopting DHI in practice and are widely accepted by physiotherapists. Digitisation also has significant ramifications, which require healthcare professionals to adapt their practices appropriately.

7.4 Barriers to using DHIs from patients' and physiotherapists' perspectives.

7.4.1 Patients' perspectives

7.4.1.1 Preference for face-to-face treatment

The most common reason for not using DHIs frequently mentioned by patients was the preference for other treatments, such as electrotherapy and acupuncture, that can only be delivered face-to-face. This preference was due to patients' perception that these treatments, such as home exercising, were more effective than others. In addition, face-to-face sessions might be more desired as this provides social activity, and the patient becomes motivated.

“I like other treatments like Chinese acupuncture or painkiller devices. For example, one day, after I did the exercise in the hospital, my leg became painful, my knees went limp, and I hurt myself. When the physiotherapist saw me, she said, “Come on,” and put a ball-like device on my knee. The pain was relieved, and I liked it”. (pt.1)

“Because if I practise alone, I do not do the exercises correctly. In contrast, when the physiotherapist is with me, I will practice and get ready for the first exercise. Then on the second exercise, I mean the physiotherapist pushes me to work harder and more”. (pt.3)

Other patients indicated their preference for face-to-face sessions due to their concern about doing an exercise wrong and their preference for the physiotherapist to be able to see and correct them.

“I like face-to-face treatment, because, for example, the therapist can correct me if there is a movement that I do not do right and may give me the opposite result”. (pt.6)

Patients also discussed how they preferred face-to-face treatment with the physiotherapist rather than sitting at home and using DHIs. These might be due to the inability to carry out self-management, and a perception that their adherence to exercise was better face to face.

Some patients expressed a lack of connection while using DHI at home and preferred the traditional face to face session.

“I do not get involved with myself at home, but if I have an appointment today and I need to go to the hospital and do the exercise, of course, I will be forced to go. At home, first, I do not have the ability to do the exercise, and second, no one can help me. You know, humans get lazy to do things alone, but in the hospital, I forced myself to go and do these exercises, and the people there helped me. In the hospital, there is a connection to appointments and to people, but at home, there is none”. (pt.7)

“Honestly, when I was going to the hospital and had specific sessions, I was more committed. When the sessions were over and I had to do it at home, I did not stick to it. This was because when I got out of the hospital sessions, honestly, I was very comfortable, and I was assured that I applied the exercises right and did everything exactly as specified”. (pt. 5)

The patient's engagement with the physiotherapist was why she preferred face-to-face.

“But you know, I was there; I was treated in the hospital, and I had physiotherapy sessions. The best thing about this was that I did not miss it (the session); I feel that face-to-face sessions are better. I was in the pool with the physiotherapist who watched me while I was practising and swimming”. (pt.2)

Other patients found that they were unable to do the exercises in the same way as the physiotherapists demonstrated them in the hospital, and showed how the physiotherapy session is perceived as a social experience and hence motivational.

“She (physiotherapist) was working hard, and I could not do it like here. Even when I my daughter tried to do similar to her in my home, she could not do the same thing for me”. (pt.6)

“One reason is that I love the gym. I saw the centre there was equipped with equipment, so I was excited when I saw the patients. I practised and spent time with the physiotherapist doing exercises; this motivates me. But when I used the application, I did not find it similar, and I think nothing will motivate me as much as the face-to-face treatment”. (pt.2)

The preference is not solely related to the face-to-face session but is also linked to the intervention's delivery method. To illustrate, an older patient preferred paper-based methods more than the use of pictures through the mobile, in particular personalised notes provided by a physiotherapist.

“I see the exercises on paper. The physiotherapist puts signs on the exercises that I should do and notes mistakes for the exercises that I should avoid. I like to deal with paper more than the phone”. (pt.7)

The next subthemes refer to the limited external support that might also link with the preference to be at the hospital and receive the support needed.

7.4.1.2 Lack of external support

From the patient perspective, one possible obstruction that impacted patients' acceptance of using DHIs was lack of external support. These included families, friends, and healthcare providers. Two participants indicated that they did not receive family support due to their busy life, work or because they lived away from their families. This was particularly important for older people who need more family support to provide technical and physical support to use the programme, which might be a possible barrier for older patients.

“My daughter helps me use the application, but her work is far from me, and I had missed appointments several times when she was not available to help me. She is busy at home with her kids and her situation. You know, I cannot do anything without her, and I have to wait for her”. (pt.7)

Not all the patients had similar thoughts regarding the need for external support. For example, patients with ACL injury stated there were no differences between attending the session or using the mobile application to do their exercise. They showed interest in the mobile application due to the pictures and videos available compared to the session with the

physiotherapist. The external influence to accept and engage with DHIs was not similar for all patients.

“All of it is the same whether you go to the centre with the specialist or go through the program, but I prefer to see the program because you can see how to do the exercises and apply them right correctly. The programme has been a relief to many people and is more comfortable”. (pt.3)

External support might be essential for some patients and is a factor that needs to be considered when providing DHIs. These might be related to the patient's condition and their age.

7.4.1.3 Lack of supportive home environment

One barrier that limited patients' engagement with DHIs was a lack of space at home. Despite the patient's self-efficacy, they could not engage in doing the exercises due to the lack of a free room in their homes.

“My apartment is too small to allow enough room for exercise.”(pt.2)

Furthermore, patients commented that a lack of equipment at home reduced their engagement with DHIs, mainly doing exercise at home, and some patients specified that this equipment did not have alternatives that they could implement in their homes.

“Other muscle-strengthening devices are unavailable at home and only available in the hospital”. (pt.5)

“The types of equipment are not available at home; At the hospital, the place is ready; for example, the bed is prepared and comfortable”. (pt.7)

“You know, in the photos of the strengthening exercises, it was not clear how I could do them at home. Some activities needed equipment like weights, and I did not know what to replace them with at home”. (pt.1)

Similarly, patients reported that the distractions from children were a barrier to being entirely concentrated during home exercise.

“Also, when she (the physiotherapist) puts the hot pack, it is very nice—not like at home. Here, no one will distract you or knock on the door (laughter), and there are no kids shouting or calling you. Also, there is mental relaxation at the hospital, and you are relaxed”. (pt.5)

Family commitment and responsibilities were frequently reported factors related to the patients. For instance, one patient discussed how suitable the application was for carrying out the exercises; however, family reasons prevented her from doing the exercise at home. Furthermore, the impact of having home-school children on self- management and sleeping time influenced the utilisation of DHI.

“You know I work outside and work at home; I mean, there is no time to exercise at home because I am busy at home sometimes. The home environment is not suitable for exercise, not like in the hospital”. (pt.6)

“I received the reminder to do the exercises, and I have to sign in. I know that this was my time for the activity. I do not know what hinders me; it might be life itself. You know, I am responsible for my home, my kids and their schooling, now that it is remote. I have to sit down with them, and after I finish with them, I have to teach them. There was no time for me; I could not find this time”. (pt.1)

7.4.1.4 Patient conditions

Patient conditions could be a barrier to the patient's engagement with the DHI. These included either the conditions of MSK or the related factors such as pain and muscle weakness. For example, a patient with a wrist fracture stated that the condition limited her ability to do the exercise, despite the simplicity of the content and the exercise. The patient expressed that she could not force herself when she felt pain; therefore, she stopped and did not engage with the exercises at home.

“The work of another person is not like your work for yourself. I mean, once you feel the pain, you will stop, not like when someone does the

stretching for you, and you bear the pain. I can't bear the pain on my own, and once I feel it, I stop". (pt.6)

"I did not use the application because I cannot do these exercises, I felt pain in the muscle above the knee, and I cannot do anything after that". (pt.7)

7.4.2 Physiotherapists' perspective

7.4.2.1 Policy changes

The role of physiotherapists was impacted by the influence of the MOH on the use of DHIs. During the COVID pandemic, some organisations immediately changed hospital policies to utilise DHIs to keep in contact with the patient, particularly during the period of strict restrictions. Physiotherapists expressed negative experiences with using DHIs and the fast implementation of different approaches that needed to be adopted and delivered to the patients. Physiotherapists explained that there were issues with how it was implemented, introduced to the physiotherapist team and how it was planned.

"Honestly it was imposed on us (laughter). Really, it is difficult to choose patients, it is difficult to find the appropriate language, and it is difficult to include the patient's seriousness. We have to try it with this patient and determine whether it will work with her or not. We must provide high-quality treatment to the patient so that we do not feel remorseful". (PT3)

Several physiotherapists mentioned facing a burden in the form of new rules from the MOH regarding the use of DHIs across all departments by 2030, which added pressure on some physiotherapists to recommend and employ such interventions, causing them stress.

"One problem that I expect is that we are obligated to the statistics, and this puts us under pressure, makes us confused, and makes us more prone to making mistakes—not like the other organisation that makes us comfortable—but with time, little by little, we will learn. As for adhering to statistics, we will be under pressure". (PT1)

7.4.2.2 Lack of training and resources

The findings of the practitioners showed a lack of consultation of practitioners before the rules were set, which might act as a barrier for them.

“I, as a physiotherapist, must palpate, feel and be aware that this is the problem. There was pressure on us from the organisation, and they did not understand what we needed. As for the staff, there was no training regarding the way we work exactly. Even the pictures that were sent to the patients were personal efforts from here, where we collected them. There was nothing prepared for the pictures”. (PT6)

7.4.2.3 Lack of peer support

Physiotherapists expressed concern about limited sharing with colleagues regarding positive or negative experiences that should be promoted or avoided.

“There are no posts between us. For example, a colleague who deals with a patient and has a good experience does not share his experience with us to help us learn and avoid mistakes. For me, in the beginning, I made mistakes and faced difficulties”. (PT7)

Sharing experiences might correlate to the best practices that could be enhanced by providing peer support, which will be discussed in the last theme.

7.4.2.4 Patient's characteristics

The patient's willingness to accept DHIs was one barrier. Physiotherapists affirmed that the use of DHIs depended on the patient's acceptance, and if the patient did not accept, these types of interventions would not be used with them. A lack of acceptance can be seen from the physiotherapist's perspective regarding the resistance of some patients to DHI. Physiotherapists also emphasised the lacking acceptance related to the limited access to the technology due to the geographic area that the patient lived in.

“I swear, some accept, while some say we do not need it. I told them, “God protect you”. (PT9)

“People living in the developing regions and distant provinces, along with the elderly, certainly do not recognise and accept these things”. (PT5)

Some physiotherapists stated that the absence of caregivers was considered a barrier to delivering DHIs for patients, particularly more elderly patients.

“The therapists are ready to deliver, but some patients are elderly, have no caregivers, have no smart equipment or do not know how to use them. This is the only difficulty”. (PT2)

In addition, the level of education and patients' age may also hinder accepting such an intervention. Many participants reported that well-educated patients had a positive attitude toward DHIs and were more willing to use such an intervention.

“Cultural and educational level. Also, patients with a university degree—and even those with high school degrees—are more aware of and more ready to accept digital applications”. (PT4)

“I used a digital health intervention almost three months ago. I had some difficulties with patients, especially older people, who often did not accept, and it was difficult to deal with them”. (PT3)

The physiotherapist also expressed that some patients had psychological issues, such as fear and anxiety, rather than physical ones. They needed more to talk face-to-face and see other patients in the waiting rooms. As previously mentioned by the patients, these might consider the reason for the preference of the face-to-face session as the social interaction that the patient perceived while attending the hospital.

“For some patients, particularly the elderly, the psychological factor is good, so they enjoy coming. God willing, they want to come to the clinic and talk to each other, so there is an aspect of self-recreation. I have observed this thing, especially in the elderly. Communication is important for people of old age, and they do not have the same number of friends or the same amount of communication when they use the application. When they come to me in the clinic, they see the same people of similar age and in similar situations, which is an excellent thing for them”. (PT6)

7.4.2.5 Preference for face-to-face sessions

In addition to patients, some physiotherapists preferred face-to-face treatment over utilising DHI in their practice due to better patient interactions. While patients' reluctance to use DHI may be a contributing factor, four physiotherapists also expressed their preference for face-to-face sessions.

“I work with the patient better in in-person sessions, for myself. I like to interact with the patient in the clinic [rather] than using [the] digital health intervention”. (PT3)

“As a physiotherapist, I prefer to see the patient in front of me. I can palpate and know exactly the location of the pain, so I found face-to-face sessions clearer, and I am comfortable as well”. (PT1)

7.4.2.6 Cultural factors

Physiotherapists indicate that patients' language might be considered a barrier. Although the same language was used by all participants (Arabic), due to varying regions and places, statements that were spoken and written about may have different meanings. In addition, some patients might be uncomfortable sending or communicating with physiotherapists using a video, particularly females, as this was considered a cultural barrier.

“Intercultural dialects, in particular, have different word dialects. This is where we encountered difficulties. Patients come to us from different cities, people from the north, from Tabuk, for example, from Hail, or something like this. They did not understand my language, and neither did I”. (PT7)

“Maybe the only barrier is that some of them(patients) are not comfortable sending videos”. (PT3)

MSK patients and physiotherapists face many barriers that impede effective care delivery; these barriers may be internal or external in nature, depending on the specific patient and organisation involved. Organisations mandating DHI intervention add additional stress on physiotherapists trying to provide DHI. Furthermore, the preference for face-to-face treatment poses one major barrier that inhibits patient engagement with DHI interventions.

7.5 Facilitators to use DHIs from patients' and physiotherapists' perspectives.

7.5.1 Patients' perspective

7.5.1.1 External support

A patient stated that the physiotherapist's communication skills enabled and motivated her to engage with the DHIs and continue her treatment.

“Honestly, she treated me well. Maybe that motivated me to keep going: her good communication style and keenness to hold virtual sessions”.
(pt.2)

The support was not limited to the physiotherapist, but also family and friends could be a motivating factor; three patients stated that the support of family and friends were motivating factors which enabled them to engage with the DHIs frequently.

7.5.1.2 Environmental facilitators

As previously stated, living in a remote area was the reason for delivering DHIs to the patients; one patient said that she lived in a rural area far from the hospital and that the use of DHIs was accepted due to these issues. Thus, living far away could be a reason to deliver DHIs and can be considered a facilitating factor that enables patients to engage with the treatment provided by their physiotherapists.

“It was wonderful and comfortable, I lived in the southern area in Albaha, and I come here for physical therapy appointments because my file is registered here. The program helped me, as I only had to go once instead of

going to hospital continuously going for a long time and tiring myself”.
(pt.4)

Other factors, such as not wasting time and avoiding having to sit at the waiting area, were considered enablers for working patients.

“It is easier for me to communicate with the physiotherapist through the app than it is to visit the centre. I benefit from efficient and quick service while I am sitting at home. I do not need to make an appointment and then go to the hospital and wait”. (pt.1)

7.5.2 Physiotherapists' perspective

7.5.2.1 Patient's characteristic

Some physiotherapists expressed that the facilitating factors do not only depend on the external motivation of their patients; the internal motivation was a crucial factor that influences patient acceptance and utilisation of DHIs; patients who worked did not have time to visit the hospital, and some patients who did not like to visit the hospital accepted DHIs as a remote intervention. In addition, educated patients and patients with high levels of self-efficacy were the most common patient characteristics that were accepted to use DHIs.

“From my experiences, not all patients were motivated, I mean, this is something internal, and I know that he wants to look after himself. Some patient does not need anyone to help; when he does the things that I send and feels that it has improved his condition, he will continue to do the same things”. (PT7)

7.5.2.2 Perceived effectiveness

Physiotherapists demonstrate that they perceived DHI's were effective in enhancing the patient's self-efficacy and adherence to the treatment plan. In addition, physiotherapists stated that DHIs strengthen their skills to communicate with patients and reduce the number of sessions in the hospital. Therefore, their daily practice schedule has a variety of cases which was very interesting to enhance their professional skills. Furthermore, strengthening

relationships with patients was one factor that physiotherapists perceived after recommending DHIs.

“I noticed that when I ask them how you do exercises at home, I found their responses better, and they do them twice instead of once, and even when she does the exercise in the session, I feel that she does it better. It seems that she wasn't disregarded and dismissed; she was already doing it at home. On the contrary, when she came to me twice in the clinic, she was a little lazy from the home program and depended on me, and it is clear that she doesn't do the exercise at home”. (PT 1)

“The patient's trust increased, and he knew I was keen on his condition because my relationship was not just at the hospital. He felt that I followed up with him at home, which increased his confidence. So, our relationship was perfect”. (PT4)

7.5.2.3 Flexible communication

Providing accessible channels for the patients and ensuring that any patient can contact the physiotherapist directly through the hospital channel link was also a facilitating factor.

“Before, patients needed to have a referral from the clinics or from the internal physiotherapy department to attend and make an appointment; however, now, anyone can access the physiotherapy channel by clicking on the link. They can ask questions and submit inquiries, and the response comes from us”. (PT8)

“I mostly communicate with patients using messages. If I have a patient or something, I will finish my duty, and if I get a message, I will make time to reply to it”. (PT10)

7.5.2.4 Preference for the blended approach

Most of the physiotherapists expressed positive experiences, with 6 of 11 physiotherapists preferring to combine DHI with face-to-face sessions. The physiotherapists expressed that this intervention is needed, and the best way is to combine it with face-to-face sessions to build trust and perform an assessment better than using DHI alone.

“I prefer to use them both because it is a must, and not all patients can attend the sessions, so using [the] digital health intervention is suitable for them”. (PT7)

Four physiotherapists preferred to use DHI with face-to-face sessions, but for specific patients and not for all cases.

“Based on patient preference, some patients prefer face-to-face, and some patients prefer to be treated remotely”. (PT8)

“I prefer both together for some cases, not for all, and I see [them as] useful and complement[ary][of] each other”. (PT4)

7.5.2.5 Cultural factors

Physiotherapists stated that no significant cultural factors hindered patients from using DHIs. They demonstrated that policymakers' development considered these factors. For example, the organisation encounters the gender barrier, and the same gender can deliver and communicate through the DHIs.

“All communication was done using my voice and pictures on WhatsApp, and all of it was with the same gender. I did not communicate with women, as you know the culture we have, where problems may occur if a man communicates with the woman”. (PT2)

Also, the physiotherapist demonstrated that the organisation provides variability in the communication portal between the patient and the physiotherapist to fit the cultural barrier and enable the patient to be comfortable while using the application.

“No cultural barrier, because we always give women all the options. For example, in the application, there are different options that allow you to chat, send a voice message or send a video. Thus, these options are always available, and women are free to choose the most appropriate option. We did not force them to do something specific or restrict them to a few options, so they could choose the thing that was most suitable for her”. (PT8)

7.5.2.6 Environmental factor

Environmental considerations, particularly geographic barriers associated with patients living in remote locations, serve as critical enablers for physiotherapists delivering DHI. For example, suppose an individual needs to travel several hundred kilometres for hospital care but cannot make multiple trips within that distance range. In that case, they require other means of treatment and support. Under such conditions, physiotherapists may find it advantageous to utilise digital health technologies like mobile health apps in order to deliver necessary care without necessitating patients to physically visit clinics or hospitals for appointments. These tools enable therapists to offer the necessary treatment without forcing physical presence at clinics or hospitals as a condition for providing it.

“Patients came from a remote area. One patient, for example, travelled 400 or 500 kilometres to come to the hospital, and he could not come to us again because of the distance, so we had to send and check on him at this time”. (PT11)

“The first reason for recommending the DHI is the difficulty faced by patients of constantly visiting to the clinic, especially for those who live far away, I mean the distance of the house away from the hospital”. (PT4)

Facilitating DHI usage involves ensuring supportive environments and resources for MSK patients and recognising its effectiveness based on individual needs. In contrast, promoting flexible modes of interaction through blended approaches and considering cultural suitability within healthcare contexts facilitates the usage of the DHI among physiotherapists. Moreover, environmental factors, particularly geographical challenges patients face in remote locations, encourage physiotherapists to deliver DHI. Therefore, these environmental obstacles act as

catalysts that promote the adoption of DHIs. Further to these facilitators factors, the physiotherapists boosted further recommendations to enhance the use of DHI among MSK patients, which will be provided under the next theme.

7.6 Ways to facilitate the recommendation of using DHIs from physiotherapists' perspectives.

7.6.1 Training and support for physiotherapists

7.6.1.1 Training for physiotherapists

Most physiotherapists expressed the need to pursue training and attend workshops to enhance their communication skills with patients digitally. Although physiotherapists received video training on using the application and logging on to the website, they expressed their need for training in communicating with patients digitally.

“Therapists need workshops; how should I communicate with the patient? We are trainees and graduates and know how to run a face-to-face session but communicating with the patient via digital way is something new. Before I apply for something new, I have to be qualified in this area”.
(PT6)

“It would be better if each hospital had simple workshops on how to learn how to use the program. They can train therapists on how to deal with patients remotely and how to provide them with exercises and pieces of advice in different ways. How can we work in this way, do a re-assessment, and describe therapeutic exercises for patients if the patients do not understand?”. (PT2)

In addition, Physiotherapists noticed that when they provide valuable input that enables patients to accept DHIs by offering sound reasons why DHIs should be used. Their experience has revealed that patients frequently accept when persuaded of its benefits and provided with assurance.

“The patient may need to ask you questions out of fear or concern, and they need to be assured when contacting the physiotherapists and understand that they are ok so that they can move on”. (PT11)

One physiotherapist stated that external training from outside of the organisation gave him an advantage and was helpful for being confident, effectively communicating, and providing effective monitoring for the patients. However, the participant stated that the training was basic and did not teach specialised skills.

“I learned some key points from doctor XXX, who taught a course, but he taught basic concepts and essential points to avoid when communicating with patients digitally; I mean, simple, not specialised skills”. (PT7)

However, training was not felt to be necessary by all physiotherapists. Three stated that recommending DHIs and communicating with the patient was not difficult and that they had the skills to conduct these activities. These physiotherapists were part of online peer groups for support and interchanging experiences. They utilised a Telegram group as a digital way to transfer educational material and communicate with the patients. In addition, even in the case of newly implemented digital programs, such as the ANNAT application (Unified digital platform in Saudi Arabia), the physiotherapists affirmed that they needed time to become familiar with the application and practice. However, as everything became easy, they believed training was unnecessary.

“The manager sent videos on how to use the website and everything I expected, and it was enough”. (PT4)

“It was a simple job, and I do not think we need extra training”.(PT9)

“It was easy to use; at the beginning, it was difficult, but after practicing, it became easy”. (PT1)

7.6.1.2 Support from the organisation

7.6.1.2.1 A clear guideline and protocol from the hospital

Guidelines for recommending DHIs were mentioned by several physiotherapists, who needed clear rules for when and to whom to recommend such interventions.

“Providing guidelines for whom digital health interventions are suitable, how to start with the patient, when to stop, what the goals that I have to achieve with the patients are... all this information needs to be provided to the therapist to understand my rules”. (PT2)

“There should be firm rules and a firm foundation for these practices (digital practices), which should not be implemented by personal choice”. (PT6)

The participants did not feel pressured as the organisation did not provide an actual number of patients with whom to engage digitally; therefore, flexibility was recommended.

“There was no pressure from the organisation regarding the number of patients I must include in the daily schedule, and this flexibility made it easier for me”. (PT8)

One physiotherapist stated that when the organisation provides an actual number of patients to include, this motivates the physiotherapist to work and increase the number of patients, as the statistics for this will be included in the annual report. Therefore, the physiotherapist's decision about whether to recommend a DHI would be influenced by the required statistics.

“Because the Ministry of Health requested the use of a digital health application as an official channel for every therapist, this motivates us to work seriously. We have to try it and enhance our experiences”. (PT9)

7.6.1.2.2 Colleagues' support

The physiotherapists declared that to become more motivated, the organisation needs to provide support by developing a peer group in which to share materials and positive and negative experiences and discuss possible solutions. Other participants acknowledged that sharing their experiences with colleagues would enhance their engagement with DHIs and recommend them to more patients. The respondents indicated that by sharing their experiences, they could avoid many mistakes.

“Sharing materials with other colleagues to motivate one another: we can share the materials we send to the patient and discuss what is easier, such as videos, photos, or explanations; this can motivate us, specialists, to use digital health interventions”. (PT6)

7.6.1.2.3 Expansion in the DHIs

Furthermore, physiotherapists illustrate linking virtual reality and gaming within the application to provide an essential measurement for the knee and functional movement and motivate the patient.

“If we could combine virtual reality, it would be better for the treatment. The patient can wear the virtual reality glasses and use the PlayStation station at home. I can set the program on the PlayStation by using iCloud and meet the patient in any cloud; it would motivate the patient and me to see the functional movement of their movement”. (PT6)

Participants also demonstrated the enhanced interactive feature linked to social media to provide a more straightforward mode of communication to patients and physiotherapists and make it easier for the patient to contact their physiotherapists, particularly when technical issues face both physiotherapists and patients. However, the social media tool is not the DHIs, but a companion to the DHIs, and this tool could be recommended to enhance interaction between patients and physiotherapists.

“The best way to recommend digital health tools is to ensure simplicity in communicating with the patients; the easier the tools are to use, the more motivation the therapist has to recommend them”. (PT 11)

“There was a technical issue with using the application to communicate with the patients, so we asked them to utilise WhatsApp as an alternative until the issues were resolved. This worked for both patients and physiotherapists until they became familiar with the application”. (PT3)

Furthermore, participants stated several methods to enhance the digital platform, including the therapists improving their materials and updating them with recent evidence.

“One essential thing is that each physiotherapist has to create their material to motivate them to work flexibly, and also we need to know the evidence behind the current research for using DHI in comparison with face-to-face treatment”. (PT6)

Other physiotherapists illustrated that providing a treatment protocol for all the conditions within the application might enhance the recommendation of the DHIs. There are some methods of developing and strengthening the application and delivering DHIs. In addition, the availability of some facilities within the application, such as clicking and pointing at the picture, would make it easier to interact with the patient. The physiotherapist also demonstrated the above by providing a survey after contacting the patient digitally, gaining confidence by receiving feedback on his/her performance.

“It is possible to have training courses. Even if surveys are available, I have to send them to the patient to know their satisfaction with digital services. This may enhance the confidence of therapists more in providing digital services. For example, if my patients were communicated with virtually and there is a survey at the end of the sessions to find out their satisfaction level and the responses are provided as statistics or as evidence that patients are convinced and have benefited from these communications, this could encourage therapists”. (PT4)

7.6.2 Enhancing patients' awareness to increase acceptance.

The awareness of the DHIs and the benefits of utilising such an intervention needs to be raised in the population. Many physiotherapists reported that this could be done by delivering a campaign in the hospital or in the mall and on social media or by providing an educational paper about the benefits of digital services.

“There was no advertisement at the hospital, and the patient has never asked me about the availability of the virtual treatment. They do not know about this service, which might be one reason the patient has not accepted it”. (PT10)

“We have to gain the patient's trust; this can be by giving each patient an educational paper to explain the privacy rules before we start using the online applications. It would be like advice that I give as to privacy, that it is impossible, for example, for anything the patient sends to go out of the system”. (PT1)

Furthermore, physiotherapists state that they have to provide a valuable point for the patient to accept using DHIs.

“There were two points that lead patients often to accept using digital health technology. First, if I said this tool makes things easier for you (patients). Second, if I said this tool helps me (physiotherapist) to keep track of you continuously even after the face-to-face sessions. These are the two most important points, and patients often like these two points, so they accept”. (PT4)

“When I told the patients that you do not need to come to the hospital, and you could access the exercises on your phone and do them at home, they often did not accept. However, they felt more secure and accepted when I told them that I would give you all the home exercises, resuming in the application, and you could come for checks after one month”. (PT3)

Overall, boosting recommendations for DHI among physiotherapists requires comprehensive training programs for practitioners; organisational policies supporting integration with clear guidelines; a collaborative work environment; and efforts to improve patient understanding and acceptance towards such technologies.

7.7 Summary

The themes discussed above highlight varying views on recommending DHIs for physiotherapists and the acceptance and use of DHIs from patients' perspectives. The Covid-19 pandemic had a significant impact, serving as one reason for using DHIs. However, the rapid implementation of these digital tools also led to several challenges that physiotherapists faced. Other themes identified key barriers and facilitators from both patients' and physiotherapists' viewpoints, an area I will delve into more in chapter nine. Physiotherapists felt that lack of consultation was a barrier to understanding their role with these new applications. While there were areas where patients' and therapists' opinions aligned, contradictions emerged elsewhere; I will interpret these findings in detail later in my discussion section. The final theme offers insights into how physios can recommend improvements to DHI features which could increase acceptance among MSK patients. In summary, though, it appears that relying solely on DHIs may not be enough when delivering for MSK patients; combining them with traditional face-to-face treatment seems necessary. In the next section, I will discuss the qualitative findings within the context of existing literature.

7.8 Discussion (Qualitative phase)

The use of DHI has attracted considerable attention and has been extensively studied, as discussed in the scoping review (Chapter 2). The aim of this phase was to explore patients' and physiotherapists' experiences of using DHI in Saudi Arabia, which is not conducted previously. Several studies have been conducted previously worldwide, and additional studies were identified after the initial scoping review (Kelly et al. 2022; Svendsen et al. 2020, Svendsen 2022). These studies are limited to patients with LBP (Svendsen et al. 2022) or as a qualitative study in one country (Kelly et al. 2022). Therefore, further research is required to understand

the barriers and facilitators for MSK patients and physiotherapists. Physiotherapists' expertise and involvement are essential for providing DHI, as the treatment of MSK relies heavily on them (Keel et al. 2021). Hence, it is crucial to comprehend their points of view. In this discussion, the primary themes from the viewpoints of both patients and physiotherapists are explored while also considering the latest research in the field.

7.8.1 Patients' perspective

The first theme that emerged was related to the beneficial role of DHI in enabling patients to manage their health. Patients had positive perspectives on using DHI, which improved their experience, especially during the COVID-19 pandemic. This positive impact was also observed in studies conducted during and after the pandemic (Meroli et al. 2022; Kelly et al. 2022), suggesting that organisations should learn the valuable lesson taught by the pandemic, such as the government rules that provided during that period to maintain social distance. Therefore, there was a limited face-to-face session which encouraged patients to explore alternatives to improve their health.

Another factor highlighted by the patients was the geographical location, with the patients emphasising that the convenience of DHI reduced the burden of travelling and improved access to care. This finding highlights the potential benefits of DHI for overcoming geographical barriers and enhancing access to care in underserved areas of Saudi Arabia. Similarly, Kelly et al. (2022) found that poor connectivity and a lack of infrastructure in rural areas of Ireland created barriers to accessing e-health services for MSK patients. This is not limited to rural areas; previous studies have shown that a lack of access to the internet in general is associated with a lack of engagement (Button et al. 2018; Kloeck et al. 2020; Parker et al. 2013). Nevertheless, in this study, patients did not mention a lack of access to the Internet, indicating that the Internet infrastructure in their areas is good. However, this cannot be generalised to all

MSK patients in rural Saudi Arabia, as the sample size for the qualitative phase needed to be bigger.

Some patients highlighted the benefit of using DHI as saving their time and communicating with the physiotherapist via the application rather than visiting and waiting for a long time. DHI was generally perceived as a time-saving application. However, this benefit was not universally recognised; some patients did not perceive the same level of time efficiency. A possible explanation may lie in patients' daily lives, as several patients reported that a lack of time prevented them from engaging with DHI. This has also been observed in previous studies (Bedson et al. 2019; Najm et al. 2020; Plinsinga et al. 2019; Svendsen et al. 2022; Sparks et al. 2015) and suggests that it is crucial to consider MSK patients' daily lives to ensure that they have time to engage with DHI.

One factor that enhanced patient engagement with DHI was excellent communication on the part of the physiotherapist. This highlights the importance of physiotherapists' ability to communicate effectively to improve patients' attitudes towards DHI use. Previous studies have also shown that effective communication can have a positive impact on patients' attitudes towards using DHI (Sparks et al. 2016; de Vries et al. 2017; Jakobsen et al. 2018; Cronstrom et al. 2019; Geraghty et al. 2019; Najm et al. 2019). Nevertheless, one of the perceived barriers to DHI uptake was a lack of motivation to use it due to the lack of physical interaction afforded by in-person sessions. This finding is also consistent with previous studies (Bossen et al. 2013; Parker et al. 2013). Kelly et al. (2022) demonstrated that it is essential to deliver blended e-health interventions to MSK patients so that they can also take advantage of face-to-face sessions.

Despite the preference in the previous literature to deliver DHI as a blended approach, some patients still did not show an interest in using DHI (Kelly et al. 2022; Parker et al. 2013). The patients in this study also had face-to-face sessions with a physiotherapist. Nevertheless, patients preferred face-to-face sessions to using DHI. This issue can be understood more deeply by integrating these data with the previous survey data collected in this study and the existing literature. The literature has identified multiple barriers to adopting DHI by MSK patients (see Chapter 2). These barriers may outweigh the perceived benefits of using DHI, thus limiting its uptake. Therefore, disengagement from DHI is the most common pattern and needs further investigation to enhance the uptake of DHI.

7.8.2 Physiotherapists' perspective

Four main themes emerged from the data, namely DHI use, barriers to its implementation, facilitators of DHI delivery and methods to increase recommendations. Overall, physiotherapists had a positive experience, which may be attributable to the pandemic, and these results align with those reported by Kelly et al. (2022), as this research and the current study took place during this pandemic's duration; therefore, its influence has had a lasting positive effect on overall experiences among physiotherapists in Saudi Arabia. The first theme demonstrated the flexibility of DHI among MSK patients. COVID-19 assisted both physiotherapists and MSK patients in adopting DHI in a similar pattern to Kelly et al. (2022), making virtual care an attractive option during pandemics to reduce the risk of infections while eliminating travel to healthcare facilities and enhancing patient empowerment to adhere to treatment plans.

These findings are similar to other studies which demonstrate the benefit of DHI in enhancing treatment plans and patient adherence and facilitating self-management among physiotherapists (Agnew et al. 2022; Kloek et al. 2020; Kelly et al. 2022; Leese et al. 2018) or other healthcare professionals. Kelly et al. (2022) provided evidence supporting this aspect of DHI's use to facilitate self-management for conditions where patients could take an active role in managing their healthcare life while becoming empowered to take an active role in managing themselves and their condition. As physiotherapists provide DHIs for various reasons, they perceive multiple factors and consider it an effective method to provide to their patients. One such factor may include improving patient relationships as physiotherapists can communicate outside working hours. However, Button et al. 's (2018) study asserted that physiotherapists faced difficulties building a therapeutic relationship with patients using TRAK (Appendix II) and needed some assurance. Some physiotherapists emphasise this point in current practice; even though there was evidence of easy DHI usage, communication issues between MSK patients were still paramount. This issue could be tied to a lack of training which has a profound impact on physiotherapists' attitudes toward providing DHI (Agnew et al. 2022; Button et al. 2018; Kelly et al. 2022 Kloek, 2020). Most physiotherapists in this study expressed a need for training to increase their skills, leading to increased confidence. Therefore, regular training was considered crucial to ensure the optimal delivery of DHI services.

Previous studies have outlined several barriers to adopting DHI by healthcare providers despite recognising its benefits (Bossen et al. 2018; Button et al. 2018; Kloek et al. 2020; Kelly et al. 2022). These studies were conducted across various countries and settings using different DHIs, yet common barriers to successful engagement with them emerged across these investigations. Many of these factors pointed to organisational influences on physiotherapists' experiences. As such, organisations should take note of these findings and meet the needs of

physiotherapists to increase the uptake and integration of DHIs within clinical practice, particularly within Saudi Arabia and globally. Factors that negatively influenced physiotherapist attitudes in this thesis included policy changes made by MOH. These included rapid implementation of DHI without proper planning, and this led to adverse experiences for physiotherapists, while lack of training, guidelines, or resources hindered their delivery effectively.

Current and prior studies differ significantly in their recommendations to enhance the features of DHIs; for instance, Bhattarai et al. (2020) and Leese et al. (2017) offer opposing perspectives in their recommendations. For example, Bhattarai et al. (2019) asserted that for digital health tools, such as Fitbit or other specific apps, to be effectively utilised by healthcare providers, they require easy patient data access. Concerns may stem from the need to seamlessly integrate DHIs and existing systems to enable effective monitoring of patient progress. Conversely, I discovered that physiotherapists in Saudi Arabia preferred more flexible platforms to integrate with existing DHI systems, such as WhatsApp. Kelly et al. (2022) found a similar finding. Studies conducted between 2022-2023 by physiotherapists demonstrated their emphasis on creating eHealth programs accessible via both internet browsers and mobile applications. While specific tools or platforms differed among studies, healthcare professionals consistently desired user-friendly solutions with easy access to patient data when implementing DHI initiatives (Leese et al. 2019; Bhattarai et al. 2020).

The physiotherapists participants in the current study reported language barriers and older mobile phones used by non-Saudi patients as unique factors impacting adversely on DHI adoption in Makkah. As this city attracts many non-Saudi individuals each month, healthcare organisations must take these factors into consideration when implementing DHIs for both

Saudi and non-Saudi patients. Thus, equal access can be ensured to DHI services for both groups of individuals. Kelly et al. (2022) provide an insightful analysis of physiotherapist experiences regarding eHealth in Ireland; however, their study does have some limitations. This was a qualitative study that recruited only 13 physiotherapists across Ireland thus they only represent a very small percentage of physiotherapists' experience across various settings and countries. Therefore, additional data integration from both quantitative and qualitative aspects must take place to produce more valid and significant outcomes. I offer an in-depth interpretation addressing existing knowledge gaps by integrating current findings with my scoping review. Furthermore, this integrated analysis will shed light on any barriers physiotherapists encounter when adopting DHI for MSK treatment within specific contexts such as Saudi Arabia.

7.8.3 Strengths and Limitations of Phase II

Research in qualitative studies relies mostly on in-person interviews to gather data. However, video conferencing platforms, such as Zoom Video Communications Inc. (Zoom), allow researchers to obtain data cost-effectively and conveniently (Gray et al. 2020). Conducting online interviews was considered a strength of the current study, as the investigation involved utilising digital technology to meet and communicate with participants. However, this approach may also have been a limitation because the respondents' participation required a level of knowledge of technology usage. This might have resulted in a sample that was naturally more aligned or receptive towards DHIs, thereby potentially influencing the findings. This method could reflect the acceptability of using an online method as part of this study. Only one male agreed to participate in the qualitative study dealing with patients. Therefore, gender bias must be considered when viewing the data. Despite this, I conducted the interviews online based on local cultural considerations because this method would reduce the cultural impact between

men and women. Male physiotherapists regularly treat male patients, so they may prefer to avoid meeting a female researcher. Conversely, the participating physiotherapists did not show a gender effect, as male and female physiotherapists had different viewpoints and could speak with one another. Therefore, future studies should consider that developing gender-balanced teams of researchers is vital to minimising gender effects.

Chapter 8

Discussion

Chapter 8: Discussion

This chapter discusses the study findings that explored physiotherapists' and MSK patients' experiences regarding the use of DHI in Saudi Arabian healthcare settings based on results from empirical evidence and the scoping review. The key findings of the qualitative phase are presented separately for both the patients' and physiotherapists' views. The integration of the three phases is discussed in detail under the constructs for each element of the theoretical framework of the UTAUT. Corroborating Venkatesh's perspective as the primary developer of the UTAUT, a discussion is conducted to determine whether the data align with each construct and to emphasise discrepancies (Venkatesh et al. 2003).

By aligning data with the theoretical framework, researchers can better understand a phenomenon of interest (Creswell and Clark 2017). To enhance the integration of the findings between the phases and provide a meaningful interpretation of mixed-methods data, grounding data in knowledge can offer valuable insights, for instance, by utilising the DHI in the real world (Morgan 2016). Creswell (2018) states that it is useful to employ theory at different stages during a mixed-methods enquiry and return to theory at the end of the analysis to identify the data informed by the theory and apply a comparison for other studies. Therefore, in the current study, contributions to knowledge can be comprehensively identified and elaborated upon at the end of the discussion chapter. Furthermore, the implications of the results are highlighted to provide insight into the current thesis's findings. They emphasise recommendations for future studies to gain more knowledge and fill additional gaps in literature.

8.1 Aim and research questions.

- **Research question: What are the barriers and facilitators influencing the use of DHIs by physiotherapists and patients with MSK conditions in Saudi Arabia?**
- The aims and objectives of the current thesis:
 1. To understand global trends regarding barriers and facilitators affecting utilisation of DHI.
 2. To explore the experiences of DHIs among physiotherapists and patients with MSK conditions in Saudi Arabia.
 - a. To map demographic details related to current DHI usage among these groups.
 - b. To understand obstacles or facilitators impacting how physiotherapists recommend or use DHI among MSK patients.
 - c. To understand factors that hinder or facilitate usage of DHI by MSK patients.
 3. To develop recommendations for enhancing DHI utilisation in Saudi Arabia.

8.2 Key findings from each phase

8.2.1 Scoping review (Chapter 2)

Before the COVID-19 pandemic and subsequent to the lockdown of 2020, a scoping review was conducted from January to July to identify gaps in the existing literature, discover the method of evaluating the use of DHI among MSK patients and explore global barriers and facilitators related to DHI usage amongst those populations and healthcare providers. The results of this review indicate that various methods are used to measure the usability and usage of DHIs, and blended approaches appear to be the most popular method of delivery among these studies. Additionally, the factors hindering or enabling healthcare providers and patients are discussed in **Chapter 2**. The key findings from the scoping review's content analysis show

that 44% of studies documented patient-provider communication as an essential factor that supports MSK patient adoption of DHI. Consequently, the need for more patient-provider communication and the complexity of the DHI are critical barriers that limit patients from engaging with the DHI. These highlight the importance of such factors from the patient's perspective. Lack of communication through DHI is not limited to the previous studies in the scoping review but has been reported recently, as a healthcare provider's insufficient involvement hinders patients from engaging with the SelfBack application (Svendsen et al. 2022), which highlights that involvement and communication of the patient-provider communication are important factors globally.

The key findings of the scoping review highlighted previously provided limited insight into physiotherapists' experiences with delivering the DHI for MSK patients. MSK patients' experiences merit more in-depth understanding to capture the complete picture of DHI use. A scoping review conducted by Agnew et al. (2022) illustrated similar findings and indicated the importance of understanding physiotherapists' views by conducting qualitative studies. Similarly, Svendsen et al. (2020) highlighted the need for more researchers to explore healthcare providers' experiences using SelfBack for LBP patients. The works of Kelly et al. (2022), Svendsen et al. (2022) and Merolli et al. (2022) were identified by replicating the search strategy used in the scoping review on a similar database, with searches conducted up until November 2022 to include the most recent literature. In addition to Agnew et al. (2022) and Svendsen (2020), three relevant studies were identified (Kelly et al. 2022; Svendsen et al. 2022; Merolli et al. 2022). Svendsen et al. (2022) explored the perception of LBP patients recruited from an RCT after using the Self Back application. Kelly et al. (2022) evaluated both MSK patients' and physiotherapists' e-health by conducting an interpretive, descriptive, and qualitative design. Merolli et al. (2022) adopted a survey for data collection and provided an

overview of physiotherapists and patients with MSK in Australia, and these studies are discussed in the following sections.

Previous studies have not fully captured physiotherapists and patients with MSK on how DHI can be utilised, which represents a research gap globally, and there are no studies conducted in Saudi Arabia either. For a fuller understanding of DHI use in real-life situations, interviews between MSK patients and physiotherapists must be taken as one objective of Vision 2030 is translating healthcare services digitally (Vision '2030' 2016). For the current study in Saudi Arabia, research was carried out that collected real-life practices data and factors which influence engagement with DHI by both participants involved. Furthermore, this study was conducted in Saudi Arabia, and the importance of this country's culture and religion has shaped all aspects of the population's attitudes. In the scoping review conducted for this thesis, previous studies provided limited insight into cultural factors that might be critical, particularly for Western countries. However, the results of the current thesis provide valuable data that can be considered for the MSK population under similar contexts and circumstances. As the UTAUT theoretical framework has been employed, similarities and differences between the current thesis's findings and previous studies in the scoping review, including, one study in Saudi Arabia, provide valuable information that can expand the understanding of DHI use in Saudi Arabia, which is discussed in detail in the UTAUT section.

8.2.2 Quantitative phase (chapter 5)

Cross-sectional research was employed to explore the general overview of physiotherapists using DHIs among MSK patients in Saudi Arabia. This section provides an overview of demographic data and the general usage of DHI, with separate physiotherapist and patient data to clarify findings.

8.2.2.1 General overview of physiotherapists' survey data

The purpose of the survey was to gather demographic data on MSK patients and physiotherapists who utilise DHI in Saudi Arabia. Furthermore, the second aim was to understand current usage and overall perception of DHIs. Quantitative data from the survey provide a general overview of the demographic data for both MSK patients and physiotherapists; the findings have been discussed previously in **Chapter 5**, which answers the second objective and provides a general overview of the DHIs utilised in Saudi Arabia. The key findings showed that almost a similar percentage of male and female physiotherapists were between the ages of 25 and 35 years (86.8%), this is similar to previous studies which indicated that younger physiotherapists were using DHI more than older physiotherapists (Kloek et al. 2020; Leese et al. 2019).

Most of the participants lived in Makkah (65.8%), a holy city in Saudi Arabia, and had between six to ten years of experience (50%), whilst a lower percentage (2.6%) of physiotherapists had more than 20 years of experience in practice. When comparing these findings with previous literature, differences were observed in the number of years of experience among the participants. Leese et al. (2019), Kloek et al. (2020), and Merolli et al. (2022) included physiotherapists with more than 20 years of experience on average. The possible explanation for these differences may be related to cultural or systemic factors which influence demographic profiles across the findings of this thesis and others.

Most physiotherapists had a bachelor's degree (81.6%), and a public hospital was the most common work setting. However, the findings of the current thesis differ from previous research studies, which include a significant proportion of participants with more than 20 years of

experience (Kloek et al. 2018; Leese et al. 2019; Merolli et al. 2022). Leese et al. (2019) conducted a focus group; qualitative studies often cannot be generalised to the broader populations. While Merolli et al. (2022) utilised a cross-sectional design that enhanced the generalisability of the findings, the inclusion criteria were broad, and physiotherapists who did not utilise DHI were also included in their study. Furthermore, variations may exist in studies conducted in countries such as Australia, Canada, and the Netherlands because of the differences in educational systems and professional requirements in each of these countries. Thus, contextual nuances among diverse populations should be considered when interpreting the results, which will provide a comprehensive understanding of the variations.

Regarding the use of DHI, 55.3% of physiotherapists had used DHI for up to 2 months, while 7% had used DHI for more than a year. This suggests that the implementation of DHI is still in its infancy in Saudi Arabia. Despite Vision 2030's mandate for digitalisation within healthcare services (Vision '2030' 2016), there appears to be a gap, particularly within the field of physiotherapy, due to limited research and understanding of regular DHI utilisation strategies specific to the current context. Furthermore, most physiotherapists utilised a smartphone-based delivery for DHI (67.1%) and reported a low usage of wearable technology (3.9%), which might indicate a clear preference among physiotherapists for using mobile applications over wearable technology, such as smartwatches and light sensor, connectivity and cost considerations play a significant challenge in the healthcare, and often represent an extra cost than utilising mobile phone application (Baker et al. 2017; Vijayan et al. 2021). Due to these various considerations, mobile phone applications may be more applicable in clinical practice than wearable technology. However, wearable technology encompasses an array of devices ranging from simple smartwatches to complex sensors, which require considerable

physiotherapist input; thus, further investigation will likely be required for an accurate comparison.

Additionally, most physiotherapists expressed that they had yet to receive training on using DHI (70%); however, despite the absence of training, there was a high level of agreement among physiotherapists regarding the statements under the effort expectancy construct. This finding offers insight into the ease of using DHI. The predominant younger age of the physiotherapists might be a factor that contributes to the perception of DHI being easy to use, the qualitative analysis of the current thesis provides valuable new insights which will be discussed by triangulating the data between survey findings and interviews. The expected use of DHI among physiotherapists (62%) was higher than the regular use (46%). Previous literature shows similar findings, despite different countries and variations in the demographic data. The low percentage of physiotherapists who use DHI has been consistently highlighted in the literature across various countries (Kloek et al. 2018; Leese et al. 2019; Merolli et al. 2022). This indicates that challenges faced in adopting DHI are not limited to specific regions but rather represent a global concern that needs to be addressed to enhance the uptake of DHIs in these populations and ensure their successful implementation in clinical practice. While these findings represent the general overview of the physiotherapists' data, the following section focuses on the overall patient demographic data and the general overview of the use of DHI by MSK patients in Saudi Arabia.

8.2.2.2 General overview of MSK patients' survey data

For the MSK patients, most respondents (85%) were female and more than half of the MSK patients had a bachelor's degree, indicating a high percentage of well-educated patients. It has been observed in previous studies that a higher proportion of MSK patients using DHI, were female and had a higher level of education, such as a diploma or a bachelor's degree (Allen et al. 2018; Bennell et al. 2018; Bossen et al. 2013; Carpenter et al. 2012; Chiauuzzi et al. 2010; Devan et al. 2019; Nordin et al. 2018). It could be suggested that the level of education might be of critical importance before delivering DHI. Previous studies reveal that the level of education may impact patients' technical skills and lead to limited engagement due to a lack of technical skills (Norman et al. 2007; Baniasadi et al. 2020). However, it could be suggested that not all non-users of DHIs are hindered by technological challenges; some highly educated individuals may decide not to utilise DHIs due to other considerations not addressed by this thesis. Overall, these findings propose that patients with higher levels of education do not face similar barriers and facilitators as those with lower levels and need further exploration.

Regarding gender, most of the respondents to the survey were female and this is consistent with previous studies in which most MSK patient respondents were female. This result can be explained by the fact that MSK issues are more prevalent in females than males (Wijnhoven et al. 2008) and that females report more MSK complaints such as LBP and knee OA than men (Alnaami et al. 2019; Tschon et al. 2021). Additionally, the online method used for data collection might be less preferred by males compared to females when it comes to participation and completion of surveys (Groves and Peytcheva 2008). The low response male rate may also result from the lifestyle of males in Saudi Arabia and their employment circumstances, which

can be considered a cultural factor that limits responses from males when this method of data collection is used.

Most participants who answered the survey had experienced their condition for over a year, and this is similar to other previous studies that found that patients with chronic disorders are more likely to engage to this type of intervention (Bennell et al. 2020; Hewitt et al. 2020; Oliveira et al. 2018; Qaseem et al. 2020). The reasoning for this might be attributed to the fact that patients with acute conditions, such as acute LBP, in the majority of cases do not need long-term management, as their symptoms resolve in a short time, or they require other types of intervention to alleviate painful symptoms. This is helpful with respect to health service resources as those with chronic conditions, may benefit from self-management systems that DHIs can provide (Hewitt et al. 2020). However, this does not imply that DHI is unsuitable for patients with acute conditions, further investigation is needed into the reason behind the limited number of participants with acute conditions.

Regarding MSK disorders, patients' age distribution was diverse, and, unlike that of physiotherapists, a high proportion of patients were aged between 26 and 55 years. The patient's diverse age distribution contrasts with previous research, where most participants were older. The possible reason for the difference in age distribution compared to previous studies could be attributed to the population demographics in Saudi Arabia. Based on the statistical report presented in Government data (2023), approximately 71.22% of the population in Saudi Arabia falls within the age range of 15 to 64 years. In contrast, only 2.6% of the Saudi Arabian population is aged 65 years or above. This report prepared by O'Neil et al. (2023) further supports that the data collected for the current thesis in Saudi Arabia would indeed have a higher representation of the population from these younger age groups, contributing to a

younger sample compared to the previous studies conducted in different countries with different demographic data. The length of use of DHIs among MSK patients was generally low, with 65% of MSK patients using the DHI for a short duration (0–2 months). Merolli et al. (2022) show that patients with MSK disorders in Australia use DHI infrequently, and this supports the findings of the current thesis. This reveals the need for further investigation to understand the reason for the short duration of usage; this will be discussed later in greater detail in the qualitative analysis, which gained a deeper understanding of the MSK patients' experiences. In addition, 71.6% of patients did not receive any prior advice on using DHI, and there were a variety of strategies that patients used, with a high percentage of them using it as an educational tool, followed by its use as a follow-up tool (Chapter 5, Table 8).

Most MSK patients (31.3%) had experience using DHI primarily for healthcare educational purposes, while 22% used them as treatment follow-up tools. This concurs with the literature where utilising DHI as a follow-up tool was the standard mode of use in the literature (Kelly et al. 2022). Furthermore, the most common mode of delivery was smartphone-based, followed by web-based delivery. The use of this mode of delivery is consistent with previous studies (Angew et al. 2022; Dahlberg et al. 2016; Jakobsen et al. 2018; Kelly et al. 2022). A summary detailing the mode of delivery used in these prior studies can be found in (Appendix II), which indicates that mobile devices are a popular medium for accessing these types of interventions among MSK patients.

The previous section offers a general overview of DHI usage and highlights the most common strategies utilised in various contexts in Saudi Arabia from the data of the current study, which helps document the current MSK patients' and physiotherapists' usage of DHI in Saudi Arabia and provides information on the areas that need further investigation. Understanding the status

of existing DHI and usage patterns, I identified areas that require additional exploration. The interpretation of patients' and physiotherapists' questionnaires will be discussed in detail in the following section, as the qualitative analysis can elucidate the findings from the quantitative analysis. The integration under the UTAUT provides a more precise understanding of these findings.

8.2.3 Qualitative phase (chapter 7)

The purpose of the qualitative analysis was to investigate the factors that impact the utilisation of DHI, as perceived by patients and physiotherapists. The use of DHI garnered significant interest and has been widely investigated, and further studies have been conducted since the initial scoping review, as discussed previously, including Kelly et al. (2022) and Svendsen et al. (2022). The major themes and findings from the patients' and physiotherapists' perspectives will be discussed in the context of emerging literature, particularly the recent literature that investigates the perspective of physiotherapists. Finally, insights will be provided into the general experiences of both participant groups (MSK patients and physiotherapists) and the potential factors influencing their views. While this study utilised the UTAUT as a theoretical framework to examine whether the findings correspond to this theoretical framework or not, UTAUT has been incorporated in the next section to provide data integration for each phase and consider the broader literature to make the incorporation more meaningful and provide answers for the second and third objectives of the current thesis.

8.2.3.1 Patients' perspective

Based on a reflexive thematic analysis of patients' perspectives, three major themes emerged from this study: the use of DHI, barriers to using DHI, and facilitators of using DHI (Braun and Clarke 2019). The first theme identified was the benefits of using DHI, particularly in empowering patients to take control of their health. This theme highlighted the value of using DHI in improving patient self-efficacy and self-management, ultimately leading to better health outcomes. The DHI's benefit to supporting self-management and enhancing the outcome was supported previously by literature (Irvine et al. 2015; Nicholl et al. 2020; Toelle et al. 2019). Indeed, the benefits of using DHI extend beyond MSK disorders and can include the successful management of a wide range of health conditions, such as diabetes, hypertension, and mental health (Free et al. 2013; Holtz and Lauckner 2015; Harith et al 2022; Kario et al. 2022). These studies indicated the success of DHIs that provide individual patients with various conditions. While these findings highlight support for the Saudi Vision 2030 which began in 2016 (Chapter 1), the goal of digital transformation in Saudi Arabia is to support the self-management of populations with chronic conditions. Despite the benefit of DHI among MSK patients, most patients prefer other treatments than using DHI, which suggests a lack of successful implementation of DHI in clinical practice in Saudi Arabia. The reason for this will be illustrated in the following sections.

Summarising the findings, based on the patient's perspective, it can be demonstrated that MSK patients perceived the benefit of using DHI. Nevertheless, the lack of physical human interaction, face-to-face session preference, and external support were identified as barriers to using DHI. These findings highlight the need for physiotherapists to know and address patients' preferences when recommending DHI.

8.2.3.2 Physiotherapists' perspective

Four major themes were identified from the data: the use of DHI, barriers to using DHI, facilitators of delivering DHI, and ways to formulate recommendations. The first theme showed the flexibility of utilising DHI among patients with MSK disorders during the COVID-19 pandemic to facilitate the adoption of DHI in Saudi Arabia. This view is consistent with that of Kelly et al. (2022) and Merolli et al. (2022), who indicated that the COVID-19 pandemic was the reason for using e-health and digital health technologies in these studies that were conducted in different countries, which emphasised the critical impact of the COVID-19 pandemic on patients and physiotherapists in terms of service delivery. In addition, organisational policies and regulations are significant factors that impact physiotherapists towards delivering DHI either positively or negatively. To illustrate, some physiotherapists expressed positive experiences towards delivering DHI, with the flexibility provided by the organisation, acknowledging their skills in communicating with patients, and the availability of peer support groups.

In contrast, most of the previous research illustrates time constraints and excessive workload as a barrier to engaging with DHI (Agnew et al. 2022; Button et al. 2018; Kleok et al. 2020), which emphasises the impact of an organisation's policies and regulations on physiotherapists' attitude towards using DHI. Physiotherapists, also agree that restrictive regulations negatively impact their performance and are stressful for them, which supports Agnew et al. (2022), Button et al. (2018), and Kloeck et al. (2020) for similar negative experiences that reflect the negative impact of the organisation on physiotherapists' attitude towards using DHI. These experiences highlight the organisation's negative and positive impact on the physiotherapists'

attitudes in the current thesis findings and the literature, which can be reflected in the low usage rate among physiotherapists identified in the survey data (**Chapter 5**). While the percentage of the intention and the expectation to use DHI was higher than the percentage of regular usage, the recommendations that the physiotherapists provided in the qualitative data suggest that there is a possibility of enhancing the uptake of DHI. This part will be discussed in the recommendation section at the end of this chapter.

While these are some of the factors that have been highlighted in the phase, a variety of additional interesting data can be discussed to explain the findings of the quantitative analysis. This can be done by integrating both sets of information effectively from the existing literature through content analysis and the findings of the current thesis from the primary survey and interview data. This integration offers a comprehensive understanding of the complexity of DHI and needs considerable insights to interpret each perspective.

8.3 Physiotherapists' and patients' with musculoskeletal conditions perspectives on the barriers and facilitators to utilise and recommend Digital Health Intervention in Saudi Arabia based on the Unified Theory of Acceptance and Use of Technology Framework and cultural factors

The theoretical framework utilised in this study is UTAUT, which was integrated with the cultural factors construct. The details of this theory and the rationale behind its selection are provided in **Chapter 3**. Four main constructs of the theory, namely performance expectancy, effort expectancy, facilitating conditions, and social influences, together with cultural factors, were investigated. This framework is justified because the study was conducted in the context of a community which values its traditions and has a specific culture, Islamic culture, that can influence them in their view of technology and the adoption of new technology in the treatment of patients.

8.3.1 Cultural factors

Comprehending the influence of culture and Islam on patients and physiotherapists utilising DHI is an important area of exploration. As stated in the introduction (**Chapter 1**), cultural factors can impact the attitude of patients with dermatological conditions (Kaliyadan et al. 2013) or general patients and physicians (Alajlani and Clarke 2013; Alanzi 2018; Alodhayani 2021) towards using DHI in Saudi Arabia or other Arabic countries. Female resistance to communicating with male doctors has been highlighted in both above-mentioned studies, even though the studies were conducted in different countries in the Middle East or even wider as the study was conducted in Senegal (Ly et al. 2017). These findings indicate the importance of cultural beliefs among the Arabic and Islamic population, particularly regarding gender segregation. However, the previous studies explored different populations, and there are no studies specifically exploring the impact of culture on using DHI's among MSK patients and physiotherapists in Saudi Arabia. As such, comparing the findings of these studies with the

present study could provide valuable data in terms of culture and the nature of using new technology, which all refer to similar areas of interest. Though, this is not the case with the findings of the current thesis, as the quantitative phase showed higher agreement among MSK patients, indicating a high perception of the compatibility of using DHI with Islamic and Saudi traditional values. The explanation for these will be provided later, considering the time when the previous studies were conducted and the potential impact on the population, as limited awareness of technology at that time may have largely influenced their findings.

8.3.1.1 Patients' view

The cultural factors were discovered with regard to the religious and Saudi traditions by understanding the compatibility of DHI with the Islamic culture and the compatibility of DHI with Saudi traditions. The quantitative phase (**Chapter 5**) provides a high agreement rate among both patients and physiotherapists about these statements 'using DHI is compatible with Islamic belief' and 'using DHI is compatible with Saudi traditions and customs', which reflects that DHI is compatible with Saudi customs and Islamic culture. Thus, patients generally perceived the compatibility of DHI with their culture, as none of the themes represented cultural barriers from the patient's perspective, supporting the quantitative data.

In the quantitative data from the current thesis, despite the high agreement for the cultural statements among MSK patients, there was one statement related to the compatibility of using DHI in their daily lives. Regarding this statement under cultural factors, 22% of the patients disagreed, whilst 18% were neutral. Although this percentage (22%) indicates disagreement, it does not necessarily reflect a high level of disagreement regarding the compatibility of using DHI in daily life for all patients. The interview data from the current thesis provide insights

into the cultural factors that enhance the understanding of this disagreement for the compatibility of DHI in their daily life. As most female patients stated, their preference for other treatments is due to their life circumstances in which the responsibilities of taking care of the home and their children are entirely upon them. These factors are related to the gender role demonstrated in the introduction, as women in Saudi Arabia are considered the main caregivers for their families (Almunajjed 1997). Therefore, gender role in Saudi Arabia is highlighted as having a critical cultural impact on MSK patients; however, caution must be applied when generalising the findings, as most participants in my data were female, and gender role might impact females more significantly than males. Hence, the applicability of these findings to a broader MSK population is limited. Although I tried to involve more men in the interview process, gender segregation has hindered the ability to fully understand their perspectives. Please refer to the recruitment section in **Chapter 6**.

The content analysis in the current scoping review (**Chapter 2**) identified that other studies refer to privacy and security as the factors that hinder MSK patients from engaging with DHI (6%) (Najm et al. 2019; Parker et al. 2013; Zuidema et al. 2019). However, these factors were not identified in the current thesis; and nor were they observed in more recently published articles (Angew et al. 2022; Kelly et al. 2022; Svendsen et al. 2022). This could be explained by the positive impact of COVID-19 restrictions, which might have enhanced patients' awareness of using DHI and concern for privacy, as the current thesis was conducted after COVID-19. Another possible explanation for the absence of privacy or security concerns among the MSK patients in my study is that DHI was provided by physiotherapists, which reduced the privacy and trust concerns that MSK patients might experience otherwise.

In addition, this discrepancy could also be due to the nature of the DHIs available to patients that have been made available under government policies and regulations prioritising user privacy and security (MOH 2022). For instance, patient access is restricted on these platforms unless they login using their national identity linked with other digital platforms used by Saudi citizens. Such stringent measures may alleviate concerns about privacy and safety which are often associated with commercially available DHIs. Furthermore, the patients were mainly recruited from a hospital setting and not from other settings such as public places or social media. This recruitment strategy ensured that the MSK patients received DHI only from an authorised place (e.g., physiotherapists working at the hospital), protecting the interests of MSK patients because they trust these places, and the privacy and security of DHI were not an issue. Previous studies showed that patients might experience adverse effects due to cultural factors when being recorded on video or in contact with a male or female (Alajlani and Clarke 2013). From the interview data (**Chapter 7**), it was found that the MSK patients had stated that the DHI was provided and communicated to them by the same gender (i.e., female physiotherapists provided and communicated with female patients), which reduces the impact of the gender segregation that the Saudi population might observe as barriers to adopting DHI. Therefore, the delivery of DHI by the same gender in culturally sensitive countries will enhance the positive attitude towards adopting DHI. Additionally, it should be noted that Saudi Arabian society is currently undergoing considerable shifts towards modernisation and openness. This societal change will potentially affect individuals' attitudes and beliefs, leading them to accept technology more readily. As such, they are becoming more comfortable managing their health using mobile applications or interacting with healthcare providers through DHIs.

8.3.1.2 Physiotherapists' view

It should be noted that the culture of Saudi Arabia is very sensitive to individuals' deep respect for traditions and religious values and might strongly influence patients' willingness to accept this type of digital intervention. As stated in the introduction (**Chapter 1**), the Saudi society possesses unique cultural values and practices rooted in its history and religion that may influence individual attitudes towards using new technology such as DHI. For instance, religion and culture in Saudi Arabia shape individuals from the primary school level itself regarding gender segregation. The impact of gender segregation might influence physiotherapists towards using such technology, mainly if there is contact between different genders. Therefore, exploring the impact of culture and religion on physiotherapists can provide evidence for successfully utilising DHIs. The literature explored in the scoping review (**Chapter 2**) did not report cultural factors influencing healthcare providers' experiences with DHI among MSK patients, except for cultural work-related factors and this aspect is further elaborated in the following section. However, given that the current thesis considers a country that values its culture and religion, it was essential to explore the potential impact of cultural and religious values on the physiotherapists within Saudi Arabia. Therefore, the current findings can fill the gap and contribute novel data to understanding of how culture in Saudi Arabia can influence the utilisation of DHIs. There are two elements that warrant discussion: firstly, the compatibility of DHI with the culture and religion of Saudi Arabia and the language barriers and lack of equipment for non-Saudi patients.

In the quantitative phase of the current thesis, most physiotherapists agreed that DHI is compatible with the religion and culture of Saudi Arabia (**Chapter 5**). Thus, cultural factors, in terms of religious beliefs and cultural values, were not considered to be barriers to the

physiotherapists' perception of the adoption of DHI in Saudi Arabia. This finding contrasts with the conclusions of previous study which found both culture and religion to have a negative impact on the willingness of healthcare providers and patients to engage with DHI (Ly et al. 2017). Furthermore, Ly et al. (20) identified the negative influence of gender dynamics among participants and religious beliefs on the successful adoption of DHI. However, these findings were not echoed in the current study. This discrepancy could be explained by qualitative insights derived from the current study.

The qualitative findings of the current thesis also emphasise from the physiotherapists' perspective that the organisations implemented DHI considering cultural factors, such as gender segregation and Islamic beliefs. For instance, physiotherapists stated that their organisations provided a variety of DHI with multiple ways to communicate with patients. The flexibility of communication channels provided to patients reduces the impact of cultural barriers that may appear, particularly in using DHI, in the context of the values and culture of a country such as Saudi Arabia. Providing multiple options of communication to MSK patients is essential to reduce the impact arising from cultural considerations, as the patients will then have the choice to select the option that suits them best. The barriers addressed in the literature regarding Islamic beliefs and cultural values do not seem to exist any longer as the organisations address the issue of Islamic religion and Saudi customs for gender segregation. This can therefore be documented in the literature and provide evidence to other researchers regarding these factors.

The second element worthy of being highlighted under cultural barriers is the language barrier. In the quantitative phase (**Chapter 5**), the physiotherapists reported a low level of disagreement (17%) for the compatibility of using DHI in daily practice, which was expanded by the

qualitative findings from the current thesis. The language barrier presents a challenge in using DHI by physiotherapists in their daily practice. When patients and physiotherapists do not share a common language, it can hinder effective communication during DHIs. The language barrier may lead to misunderstandings about treatment plans or exercises, potentially compromising the quality and effectiveness of care provided through these platforms. Therefore, addressing such linguistic barriers is crucial for the successful integration and routine use of DHI in daily physiotherapy practices. Physiotherapists reported that language barriers were one issue in dealing with diverse languages, particularly for physiotherapists working in Makkah. In this study, the introduction mentioned that people of various nationalities often visit Makkah to perform Haj. Although not all physiotherapists explicitly stated in the qualitative phase, some confirm that language barriers exist due to different linguistic backgrounds, despite sharing the Arabic language. This is consistent with the previous literature that considers language act as a barrier for healthcare providers in Saudi Arabia (Almutairi 2015). Although these studies were published in 2015, the issues are still relevant.

In addition, one of the cities covered in the study is considered a holy city for Muslims (Makkah), and as such, it often has a mixture of nationalities at any one time. Therefore, both Saudi and non-Saudi patients can enter the hospitals, and physiotherapists need to be able to treat all patients (**Chapter 1**). Thus, healthcare services are provided free to all pilgrims who visit public hospitals. In the interviews with physiotherapists, some of them emphasised that the issues exist with non-Saudi patients because many of these visitors do not have mobile devices. This would make use of DHI, via smartphones not feasible.

8.3.2 Social influence

Social influence is crucial in hindering or facilitating patients' engagement with DHI in Saudi Arabia and globally. The findings from the scoping review, survey data and patient interviews from the current thesis reflect consistent agreement regarding the influence of social factors on patients' use of DHI. While previous studies on DHI may not directly use social influence as a specific term, they refer to the need for communication, involvement of the healthcare provider and building therapeutic relationships between patients and providers (Agnew et al. 2022; Kelly et al. 2022; Svendsen et al. 2022). These aspects highlight the importance of social influence for patients and healthcare providers and indicate the need for researchers to explore this area. This section provides my argument on the importance of social influence, particularly in Saudi Arabia, as triangulated by the findings from the scoping review, mixed methods and supported by recently published studies.

8.3.2.1 Patients' view

Figure 12 (**Chapter 5**) shows survey data from the current thesis. The social influence construct illustrates the percentage of agreement, demonstrating a different pattern of agreement and disagreement compared to other bar charts in **Chapter 5**. These findings suggest that MSK patients experience varying levels of conflict concerning the social influence construct, highlighting the complexity and diversity of opinions among MSK patients utilising DHI in Saudi Arabia. The differences in responses emphasise the need to consider these contrasting perspectives when addressing issues of social influence, which is critical in collectivist countries such as Saudi Arabia. In collectivist countries, the impact of social factors can be vital due to the emphasis on group harmony, interdependence, and strong interpersonal connections (Hofstede et al. 2011). As stated previously, cultural values in collectivist countries prioritise society's health over individual interests (Leong et al. 2022), making it essential to

consider how social influences may form individuals' perceptions and behaviours when addressing complex issues related to DHI.

According to Venkatesh's theory, in terms of utilising DHI, when patients perceive support from their social networks, such as family and friends, including belief in the DHI concept, they are likelier to adopt these types of interventions (Venkatesh et al. 2003). The pattern in **Figure 12** shows some level of disagreement (28%) and some neutrality (39%) among MSK patients regarding the belief from their family or friends that they should use DHI. This figure may illustrate that patients did not perceive the importance of DHI when their family and friends did not believe in using this intervention. The interview findings (**Chapter 7**) support this finding and indicate that MSK patients who experience support and encouragement from family and friends in using DHI demonstrated a positive attitude towards this technology. In contrast, those without such social influence or belief in their immediate circle were less inclined to adopt DHI, which highlights the importance of believing the part of social networks in forming patient attitudes and receptiveness towards DHI, particularly when planning strategies for promoting adoption within various MSK populations.

The impact of social influences, such as support from family or friends, on the patient's attitude towards DHI, as illustrated in the current research thesis, was not evident in previous research (**Chapter 2**). There are several possible explanations for this discrepancy. Firstly, the current thesis aims to explore the cultural context, which could play a role. This study was conducted in a Saudi Arabia setting where social influences are more significant compared to the individualistic societies examined in previous studies, which may not have considered social factors critical to patient behaviour in terms of using DHI. The impact of social influences on

patients' attitudes towards utilising DHI might be less pronounced in individualistic societies compared to collectivist societies (Hofstede et al. 2011), such as in Saudi Arabia.

Secondly, methodological differences also play a role. For example, the analytical approaches in the current thesis led to a different emphasis on the impact of social factors across studies. To illustrate, inductive and deductive approaches were adopted in the current study to analyse interview data (**Chapter 6**). In contrast, others have adopted inductive analytical approaches, focusing only on the patient's experiences for the short intervention period, such as TRAK (Button et al. 2018) or utilising reflexive thematic analysis (Kelly et al. 2022). While reflexive thematic analysis is a valuable approach for analysing qualitative data, it involves the researcher's active engagement with their subjectivity throughout the research process (Braun and Clark 2019). Reflexive thematic analysis may introduce bias if the researcher does not disclose their prior assumptions and clearly outline the process of reflection they undertook. Otherwise, it can potentially introduce biases and personal interpretations that may influence the findings. Additionally, conducting pure qualitative research indicates that findings are context-specific and that the results might not be directly applicable or generalisable to other populations or settings (Porteny and Watkins 2013). This result is also impacted by the researcher's subjectivity, which can affect the research findings.

Many of the previous studies in the scoping review indicated the positive impact of communication between patients and healthcare providers as a facilitator (**Chapter 2**). Thus, social influence factors could also be present in individualistic societies and may not be related to family and friends. Physiotherapists' attitudes and communication skills can significantly affect patient engagement with DHI. The majority of MSK patients agreed that their relationship with their physiotherapists improved when using DHI (73%). In comparison, a

smaller number disagreed (13%) and some remained neutral (13%), as shown in **Chapter 5, Figure 12**. Furthermore, 51% of the patients concurred that physiotherapists believe they should use DHI. This finding emphasises the significant influence that a physiotherapist's attitude that can have on patient perceptions. Similarly, interview data from **Chapter 7** revealed that patients highly value the support and effective communication provided by their physiotherapists. These findings emphasise the crucial role that healthcare professionals play in fostering positive attitudes toward their patients. Therefore, policymakers and organisations should consider the importance of families' and friends' views about DHI and the support that physiotherapists provide to patients. Notably, social influences are not limited to surrounding family, friends or healthcare providers; the government's rules could also play a significant role in shaping MSK patients' attitudes towards using DHI, which will be discussed in the following paragraphs.

Other factors in the current thesis' findings are the impact of COVID-19, the resulting restrictions and the lockdown period, which could have potentially impacted MSK patients' adoption of DHI and therefore affected the findings. For example, the survey data for MSK patients (**Chapter 5**) indicated that their behavioural intention was higher than their regular usage. According to Venkatesh et al. 's (2003) UTAUT model, having a strong intention to use technology should lead to regular and actual usage of it. However, Venkatesh et al. (2003) also recognised that other factors can affect end users and their regular usage of a technology. The impact of social influences can be one factor that influences individuals' intentions and their regular use of DHI. The government in Saudi Arabia made COVID-19 restrictions mandatory for all cities (Yezli and Khan 2020), indicating a high level of authorities' influence on the population's attitude. Government rules and policies can act as a form of social influence on a population's attitude towards using DHI and this impact also be confirmed by Neville et al.

(2021). During the COVID-19 pandemic, the government was crucial in promoting health measures and encouraging citizens to adopt new technologies for healthcare access (Ohannessian et al. 2020). By implementing restrictions that limited face-to-face interactions and endorsing DHI as healthcare services instead of face-to-face sessions, such government rules could shape public perceptions of these technologies' importance. This factor may lead to increased acceptance and adoption among the general population. Furthermore, when trusted authorities endorse specific practices or tools for managing healthcare needs during challenging times, such as the pandemic, it is likelier that people will be receptive to adopting those recommendations (Bish and Michie 2010; Siegrist and Zingg 2014). This endorsement can lead to a change in individual behaviour and increased acceptance of the recommended alterations and can explain the finding of behavioural intention among MSK patients in Saudi Arabia (**Chapter 5**).

The scenario of implementing government rules during the pandemic and subsequent changes in MSK patients' behaviour can be considered an example of social influence based on Bandura's (2001) SCT (**Chapter 3**). According to Bandura (2001), individuals learn from observing others' behaviours and consequences within their social environments. The rate of MSK patients' behavioural intention to use DHI in Saudi Arabia was high, particularly during the pandemic, indicating that individuals adjust their behaviour according to perceived norms established by authoritative figures. However, the regular usage rate was lower than the behavioural intention rate (**Chapter 5**); when restrictions related to the pandemic are lifted, MSK patients may not fully engage with DHI solutions, as they did during strict limitations. Consequently, the regular usage rate of DHI might be lower than anticipated. This suggests that, while government-imposed rules and social influence played a role in promoting DHI adoption under specific circumstances, long-term engagement and sustained utilisation may

require additional factors to maintain interest and commitment among MSK patients once regular healthcare services resume. The interview data (**Chapter 7**) supported the survey data mentioned above, as patients used DHI due to restrictions and COVID-19 shifts. Furthermore, less than half of the patients agreed that there was a perception of prestige with the use of DHI with others and (30%) disagreed. This could suggest that despite mixed opinions regarding its prestige, some patients do not perceive the long-term benefits of DHIs and nor do they associate its use with others as a positive health behaviour. This is one possible reason for disengagement when considering the influence of social support, although there may be multiple other factors. However, when considering Saudi Arabia, the value of one's social life and the impact of other people on the patient's attitude must be critically evaluated. Therefore, social influence could potentially motivate patients to continue using DHI in Saudi Arabia.

By considering the factors mentioned earlier, policymakers, researchers and organisations can address this by informing the general patient population about the long-term benefits of DHI. This was recommended by physiotherapists in the current interview findings and appeared essential from the discussion when triangulating the data between the phases and integrating them with the previous literature. Social influence was crucial not only for the patient but also for physiotherapists in the current and previous studies. The significant impact of social influence on physiotherapists will be discussed in greater detail in the following section.

8.3.2.2 Physiotherapists' view

Social influences identified in the current study reveal some degree of concern regarding physiotherapists' perceptions about using DHIs for MSK patients in Saudi Arabia. Based on the qualitative findings from **Chapter 7**, these concerns may stem from various sources, which could include from patients themselves, healthcare colleagues or government regulations such

as COVID-19 regulations. Thus, experience should be utilised when devising strategies to promote DHI for treating MSKs throughout Saudi Arabia. As discussed in **Chapter 5** (survey data), Figure 6 shows a proportion of physiotherapists who disagreed with the statement that patients think physiotherapists should use DHI with them (50% disagreeing and 7% totally disagreeing). This could reflect the fact that, on average, physiotherapists perceive a relatively low level of MSK patients demanding the incorporation of DHI into their care. This finding is supported by the second phase of the mixed methods approach, as physiotherapists may be influenced by the patient's condition or their acceptance of adopting DHI (**Chapter 7**). The interview data presented in that chapter revealed that MSK patients who did not accept or were unwilling to use DHI acted as a barrier for physiotherapists to deliver these tools. Consequently, social influence shapes physiotherapists' delivery based on patient acceptance and willingness to engage with DHIs.

In addition, as physiotherapists recommended enhancing awareness among MSK patients, it was recommended to provide a campaign on DHI availability and the benefits of using this type of intervention. In addition, physiotherapists demonstrated that patients who were unwilling to use DHI would not be forced to do so, influencing the physiotherapist's decision to deliver DHI to those patients. Therefore, this suggests how patients can influence physiotherapists' attitudes towards delivering DHI to them. These results were consistent with the previous studies demonstrating that DHI might not be suitable for all MSK patients and may depend on the patient's interest. Kelly et al. (2022) showed that physiotherapists acknowledge that e-health might not interest all MSK patients; therefore, they endorse the flexibility of providing e-health based on the patient's interest. In addition, Bhattarai et al. (2020) explored allied health professionals' views and reported similar concerns regarding the suitability of mobile applications for certain patients, such as older individuals with arthritic

pain, which aligns with the current thesis's findings. Therefore, comparing the current thesis's findings and previous literature can further highlight how crucial it is for healthcare providers across different disciplines (e.g., physiotherapists vs allied health professionals) and across different countries to tailor their approaches based on specific patients.

Social influence does not only extend to patient acceptance or associated characteristics; instead, these aspects play a pivotal role in shaping physiotherapists' attitudes about adopting DHI in Saudi Arabia (**Chapter 7**). Physiotherapists who received support from peers and shared positive experiences had more favourable views of DHI than those working alone and expressing negative opinions about it. This finding differs from previous studies conducted in individualistic societies, where peer influence may have had a weak effect (Liu et al. 2014). This thesis' findings reflect Saudi Arabian society, where interpersonal relationships play an integral part when making decisions among physiotherapist professionals. Additionally, the age demographic of physiotherapists influenced the current findings. Most physiotherapists could be regarded as younger, and younger physiotherapists might be more susceptible to influence from peers due to their limited experience or being in the early stages of their careers and potentially seeking guidance or validation through colleagues during that time. While younger physiotherapists may be more inclined to use DHI due to their general familiarity with technology than older physiotherapists, they might still require guidance and support in integrating DHI effectively into their clinical practice.

Social influence also can be confirmed by the 40% of physiotherapists who agreed to viewing the use of DHI as prestigious, thereby indicating a level of recognition within some parts of this professional community about the potential benefits and status associated with using new technologies such as DHI. However, physiotherapists also demonstrated a level of neutrality

(45%) regarding the perceived prestige of colleagues who use DHIs in their practice (**Chapter 5**). Further exploration through the interviews which was discussed above revealed that peer support benefits were valued more highly than any perceived prestige associated with DHI usage among colleagues. Therefore, the findings of the current thesis contribute valuable insights for informing targeted strategies aimed at promoting widespread DHI acceptance by physiotherapists in Saudi Arabia.

During the COVID-19 pandemic, government regulation also impacted physiotherapists' attitudes regarding using and providing DHI therapy among MSK patients in Saudi Arabia. The discussion was presented above from a patient-centric view regarding the impact of government regulations during the COVID-19 pandemic and their effect on MSK patients' behavioural intention to adopt DHI practices. These regulations influenced physiotherapists because their behavioural intentions exceeded their regular usage (**Chapter 5**). Interview data also confirmed these findings by showing that one reason DHI usage was due to the COVID-19 pandemic effects (**Chapter 7**) and meeting Vision 2030 targets (Vision '2030' 2016; **Chapter 1**). The government's regulations, which were implemented in early 2020, and they positively impacted physiotherapists' acceptance of DHI; however, after restrictions eased, along with the influence of other factors that physiotherapists recognised, their regular usage may decline. Previous studies also supported the reduction of physiotherapists utilising DHI among different MSK patients (Button et al. 2018; Kloek et al. 2020; Merolli et al. 2022), which emphasised that either the government or other factors mentioned previously impacted physiotherapists in delivering DHI. Possible recommendations that are uniquely for physiotherapists in Saudi Arabia are recognised and highlighted in the current thesis for researchers, organisations and educational sectors to address these barriers.

8.3.3 Effort expectancy

Previous research has consistently maintained that ease-to-use is a crucial factor associated with the adoption and utilisation of DHI, and therefore, they often utilise TAM, as a theoretical framework (Davis 1989; Sun et al. 2013). However, this construct in the current thesis might not essentially impact physiotherapists or patients in Saudi Arabia to use DHI. To illustrate, as per the UTAUT framework, a participant's perception of how easy it is to use a particular technology will lead to a positive attitude of end users to engage with these new interventions (Venkatesh et al. 2003). Essentially, if participants find a DHI easy to use, they are more likely under this theory's principles, have a positive attitude and be willing to engage further in such interventions. However, patients and physiotherapists agreed highly with this construct in the survey (**Chapter 5**). Accordingly, DHI was not difficult and, therefore, might not be a barrier for either patients or physiotherapists.

8.3.3.1 Patients' view

Despite a high level of agreement among MSK patients regarding effort expectancy, there were also low levels of disagreement noted among the respondents, as detailed in **Chapter 5**. The qualitative data provided insight into some minor disagreements among respondents because older patients demonstrated difficulties handling the mobile application feature (**Chapter 7**). Lack of the usability of the DHI among these participants might limit the patients' use of DHI, especially older patients. This finding aligns with Venkatesh et al.'s (2003) view that an individual's age can influence effort expectancy. The older population may require help to use certain technologies. Comparing the findings to the scoping review through the content analysis, only 18% of studies reported that DHI was usable, indicating that DHI might be easy

for some patients. Furthermore, another study reported that DHI was not usable, which was based on the functionality of the application or even the condition of a patient, which supports the finding of the mixed-methods design used in the current thesis (Mollard and Michaud 2018). To illustrate, most patients reported that DHIs were easy to use, which might also be related to the population demographic data, such as younger people with high educational levels. At the same time, not all MSK patients agreed (**Figure 10**) that it was easy to modify exercise and understand information provided by DHI because 20% disagreed and 21% remained neutral, thereby indicating that DHI might be challenging for some patients, depending particularly on a patient's condition. A patient's condition could limit their engagement with DHI, even if it were easy to use. Mollard and Michaud (2018) showed the difficulty faced by patients with hand RA to use mobile applications and reported that the difficulty was caused by their physical condition. Therefore, DHI might be easy to use, and the COVID-19 pandemic might have increased the use of technology and DHI, making patients become more familiar with using such type of intervention (Kelly et al. 2022). However, although DHI is considered to be easy to use, caution must be exercised depending on the condition of MSK patients. In addition, it should be considered that the participants in the current study were young, and the majority had a bachelor's degree, indicating well-educated patients. Therefore, the lack of technical skills might not be considered a barrier for such populations, which might, however, limit the generalisability of the results.

8.3.3.2 Physiotherapists' view

From the survey findings, physiotherapists reported mixed views of agreement regarding the usability of DHI for their patients, even though the majority agreed that DHI is easy to use and that they had learnt it on their own. This indicates the concern of physiotherapists about the usability of such interventions for their patients. These concerns were identified when conducting the interviews (**Chapter 7**), highlighting the importance of conducting a mixed-methods design, as relying on one method may not provide a comprehensive understanding of the concerns and issues of using DHI. Interviews with physiotherapists provided a deeper insight into their concerns. They related that DHI is unsuitable for all MSK patients, particularly older patients without a caregiver and those lacking technical skills. These concerns are consistent with the previous literature discussed in the scoping review. Bahhatari et al. (2020) concluded that healthcare providers are concerned about the familiarity of older patients to download and utilise applications for their health, which supports the findings of the qualitative phase of the current thesis.

The content analysis revealed that 12% of the studies reported the barriers of lacking familiarity with using and engaging with DHI. However, the lack of familiarity may not be higher in the scoping review or even in the quantitative data from the current thesis, which indicates that familiarity with DHI is not a significant factor that hinders physiotherapists from engaging with DHI. It is worth noting that these findings from my scoping review conducted globally and the mixed-methods study limited to Saudi Arabia do not mean that the simplicity and user-friendly nature of DHIs were not significant factors to consider; however, other factors (e.g.

social influence), in the context of using DHI in Saudi Arabia, play a significant role for both categories of participants than effort expectancy.

8.3.4 Facilitating conditions.

Generally, the findings from the quantitative phase (**Chapter 5**) show that the majority of MSK patients have the resources that support them in using DHI. However, they still do not use it as regularly as expected (e.g., short duration of usage and lower regular current use than the behaviour intentions rate), which indicates the need for further investigation. In the present discussion, the findings from the different phases of this study have been integrated, and the views of the MSK patients and physiotherapists have been considered separately to make it clearer.

8.3.4.1 Patients' view

One facilitating factor related to the environment and context of Saudi Arabia is the absence of healthcare services in rural areas, leading to the enhanced patient acceptance of DHI. To illustrate, females in Saudi Arabia were prohibited from driving until recently; therefore, the availability of DHIs facilitates their adoption among female patients living in places that are far from a hospital and where access is limited due to the lack of transportation and healthcare services in their areas. Despite the driving ban being lifted in 2018, some patients still can not drive and, therefore, they are more likely to accept DHI. One of the important reasons for implementing digitalisation (Vision '2030' 2016) was to enhance access to healthcare services for patients in rural areas, which the availability of DHIs can facilitate.

Facilitating conditions were mentioned frequently in the scoping review (**Chapter 2**). The majority of the studies refer to technical skills, access to the internet, training, and previous

knowledge. This might differ from the findings of the current thesis as the facilitating conditions and technical issues were not considered barriers from the patient's perspective. This can be due to several factors that enhance technical awareness such as the COVID-19 restrictions and lockdowns that moved more healthcare services in the world to remote access. In this context, Kelly et al. (2022) reported that COVID-19 had a positive impact on MSK patients for the use of e-health in Ireland. From the survey (**Chapter 5**) conducted in this study, I found that the patients had positive perceptions regarding facilitating conditions, and this is supported by the qualitative finding (**Chapter 7**) that limited technical skills were not a barrier except for the older patients.

As mentioned above, the majority of the MSK patients agreed with the facilitating condition construct (**Chapter 5**). The qualitative findings support this in the sense that the lack of healthcare services for patients who lived in a different city or in rural areas led to their adopting DHIs. However, despite the MSK patients agreeing that resources were available for adopting DHI, there was also some level of disagreement among the respondents (**Chapter 5**). Interviews of MSK patients (**Chapter 7**) revealed additional barriers not captured by survey data alone (e.g., the lack of space at home and defective equipment). While the UTAUT provides valuable insights into technology adoption, it may not fully capture all the relevant factors affecting MSK patients' behaviour towards DHI. Kelly et al. (2022) also emphasised the lack of space in their recent study in Ireland, which is consistent with the findings of the current thesis. Therefore, environmental constraints emerged as essential considerations beyond traditional constructs, suggesting further research to investigate how environmental factors influence MSK patients' decision to use DHI and interact with the established facilitating conditions construct.

8.3.4.2 Physiotherapists' view

Facilitating conditions were considered important by the physiotherapists as well. If they believe in the existence of infrastructure, such as the availability of resources and support from organisations, it would enhance their behavioural intention and ultimately lead to the adoption of technologies (Venkatesh et al. 2003). However, this is not true for all technologies, particularly healthcare services. The availability of infrastructure for DHIs, providing training specifically for the interventions, and access to resources were essential. As reported in the survey data (**Chapter 5**), physiotherapists did not engage with DHIs regularly in Saudi Arabia due to several factors, and training requirements are one of the crucial factors that have to be considered in greater detail from a policy perspective. Furthermore, the training provided by the organisation and also the regulations and policies that had to be followed impacted the physiotherapists' attitudes towards adopting DHI.

Providing training for healthcare providers to understand how to use DHI is crucial, and it may not be as challenging as initially perceived. Given that healthcare professionals who are well-educated, can quickly learn and adapt to new technologies once they receive proper guidance and instruction. The main issue, however, is that the training that is generally provided focuses on the technical aspects of the intervention and ignores other essential factors, such as how a healthcare service provider should communicate with their patients regarding the adoption of DHI. This shortcoming was indicated by the physiotherapists in their interviews (**Chapter 7**). Previous studies have also reported that it is essential to provide training to make it easier for physiotherapists to understand new types of interventions (Button et al. 2018; Kloek et al.

2020). The physiotherapists in the Button et al. (2018) study reported that the training they had received was sufficient and that it was easy for them to use digital interventions. However, the use of TRAK intervention by physiotherapists had declined, indicating that other barriers could have led to this decline. It could be proposed that the lack of training in how to integrate TRAK into their clinical consultations could be the reason for the decline in its use.

Furthermore, Kloek et al. (2020) mentioned that instructions about the web application were provided. However, there was an absence of relevant content in the training that was provided to the physiotherapists to become familiar with the intervention. As such, despite providing training to physiotherapists, only 8% of physiotherapists used the web-based application. The physiotherapists in the Kloek et al. (2020) study expressed that web-based applications require time and emphasised the technical skills and the calcification of the change in the treatment routine as the factors that hindered them from using the intervention (Kloek et al. 2020). Therefore, the type of training provided, as reported in previous studies (Button et al. 2018; Bhattarai et al. 2020), may not be adequate for physiotherapists, which is consistent with the findings of the current thesis.

The second factor considered crucial by healthcare providers as per previous studies was the lack of time and heavy workload as barriers to the uptake of DHI in their clinical practice which is reported by several other studies (Agnew et al. 2022; Bhattarai et al. 2020; Button et al. 2018; Kloek et al. 2019) which indicated the existence of cultural-work related factors. These factors (e.g., time constraint, workload, etc.) can be related to the policies and regulations of the organisations that implemented DHI. It should be noted that integrating DHI into clinical practice takes work and needs time for the physiotherapists and the organisation. Despite half of the physiotherapists agreeing the compatibility of using DHI in their daily practice, there

was also some level of disagreement (**Chapter 5, Figure 8**). This indicates that some physiotherapists may find it difficult to integrate the use of DHI in their daily practices. In addition, implementing DHIs in restrictive policy and regulatory environments can lead to low adoption rates, as illustrated by the finding of the current thesis (**Chapter 7**). This can also provide evidence of the impact of the cultural-work related factor that either has a positive effect if the organisation provides sufficient support or has a negative effect as the regulation and policy changes associated with the negative impact declared by the physiotherapists in the qualitative findings. Therefore, the impact of organisational rules (i.e., policies, regulations, guidelines) on physiotherapists' adoption and use of DHI is indeed crucial.

The reason for the reported lack of time can be explained by the nature of the setting that the healthcare provider is working in Klock et al. (2020). explored the experiences of physiotherapists working in private clinics, a setting that necessitates meeting certain daily targets by the physiotherapists. As this might influence the physiotherapist to accept, engage with, and deliver DHIs. Furthermore, working in public hospitals also can be overwhelming as the high demand for healthcare services might act as a barrier for healthcare providers to deliver DHIs. Button et al. (2018) stated that the physiotherapists working in the NHS in the UK expressed a need for more time in the consultation to introduce DHI to their patients. Therefore, providing different regulations based on healthcare preference would solve this issue and enhance the utilisation of DHI, which was mentioned as a recommendation by the physiotherapists during the interviews (**Chapter 7**).

Based on the survey findings, there were mixed views regarding the availability of resources (**Chapter 5, Figure 7**). Availability of resources is an essential condition, and physiotherapists expressed their need for standardised content and guidelines to enhance the uptake of DHI.

This concurs with previous studies that expressed the need for guidelines and supported evidence-based content (Bhattarai et al. 2020; Kloek et al. 2020) and needed extra resources (Kelly et al. 2022). All these are consistent with the findings of the current thesis (**Chapter 7**) and highlight the importance of providing these elements to enhance the uptake of DHI among physiotherapists in Saudi Arabia and globally. Resources are essential for physiotherapists, such as devices, and internet access, which increased after the pandemic (Kelly et al. 2022); however, they still expressed their need for more than what was made available. All organisations need to provide the resources that physiotherapists require to facilitate the uptake of DHI, and this is particularly for organisations that make the use of DHI mandatory, as in the current study (**Chapter 7**). It should be noted that resources alone are not sufficient and that professional training and support from the organisation are also necessary.

Another important factor reported by the physiotherapists (**Chapter 7**) was the burden of the policies and regulations existing in their organisations. The factors that may negatively influence physiotherapists' attitudes include the policy changes implemented by the MOH. There were also frequently mentioned previous evidence, as discussed in the scoping review, that change in work rules, schedules, time for the sessions, and even the time that the healthcare provider needs to work outside the hospital were all factors that negatively impacted the attitude of professional healthcare providers with resulting negative experiences, which could in turn lead to a lower rate of delivering DHI (Agnew et al. 2022; Bhattarai et al. 2020; Bosson et al. 2016; Button et al. 2018; Kloek et al. 2020). Thus, a rapid implementation of DHI, with insufficient planning, resulted in negative experiences for physiotherapists and the lack of training, guidelines and resources provided by the organisation hindered their ability to deliver DHI effectively.

8.3.5 Performance expectancy

The concept of performance expectancy will be explained in relation to the findings of the current thesis to provide the support and conflict that exist from the perspective of both patients and physiotherapists. Overall, both MSK patients and physiotherapists in this study perceived the value of DHI; however, the majority of the MSK patients stated their preference for face-to-face treatment, while some of the physiotherapists expressed their preference for traditional treatment. Physiotherapists expressed a positive attitude towards delivering DHI to MSK patients. However, their agreement on the regular use of DHI was lower than their intention and expectation of its use in the future, indicating that other factors may hindered physiotherapists from regularly using and delivering DHI.

8.3.5.1 Patients' view

The MSK patients in this study reported the perceived effectiveness of using DHI, as most of them agreed that DHI was useful as detailed under the performance expectancy construction in the survey findings (**Chapter 5**). The interview data also confirmed this to illustrate that patients reported that pictures and videos provided for the adoption of DHI were more helpful than just verbal instructions in clinical settings because the latter helped them to remember the treatment plan they had received from their physiotherapists (**Chapter 7**). As evidenced by Venkatesh et al. (2003), if the end user perceives the benefit of using DHI, this will enhance their use of a particular technology. However, the regular usage of DHI was low and the duration of use was limited to less than two months (**Chapter 5**). Additionally, there was a mixed view regarding the statement that DHI was compatible with their needs. This indicates that some MSK patients did not find DHI compatible with their needs due to several factors.

In order to enhance understanding, it is important to know the patients' needs and preferences and this can guide the technology developers and healthcare providers (Murray et al. 2017). Interviewing patients and gaining a deeper understanding of their experiences provides valuable data and enhances our understanding of their preferences and needs. The MSK patient interview data (**Chapter 7**) revealed that preference for other types of treatment, particularly face-to-face sessions with physiotherapists, significantly hindered the patients from using DHI.

Preference for other treatments was the key finding from the qualitative phase that can justify the differences in the responses as mentioned above. Previous studies reported that due to limited interest in the use of online systems, lack of motivation, or for other reasons, patients showed a preference for face-to-face sessions (Kelly et al. 2022; Plinsinga et al. 2019). Indeed, changing the usual method of traditional face-to-face treatment to digital methods is not an easy process and needs time for successful transfer. These studies reported patient preference for face-to-face sessions (Kelly et al. 2022) even in cases where DHI had been implemented several years ago. Therefore, this was not surprising in the findings of the current study, as DHI has been introduced in Saudi Arabia only recently.

Furthermore, in the studies that did not show that patients prefer face-to-face treatment, there was some argument about the approach provided. Cronstrom et al. (2018), in their study of a patient with knee and hip OA, reported the perceived effectiveness of utilising digital programmes. However, one essential part of the treatment was regular contact with the physiotherapist in a digital format. Cronstrom et al. (2018) reported that providing the patient with daily contact with their physiotherapist was effective in making the patient satisfied and continuing their use of DHI. This data concurs with data from Geraghty et al. (2019), which reported regular contact between patients and physiotherapists, resulting in the LBP patients

feeling more supported and showing their continued interest in DHI. These studies indicate that patients need regular contact with their healthcare service providers to feel confident about their treatment; however, this cannot be applied to clinical practice in hospital settings, as the need for regular contact with patients will add workload for physiotherapists. This workload is confirmed by Button et al. (2018) and Kloek et al. (2020), who reported that the use of DHI increased the workload during the clinical practice. In contrast, patients consider the insufficient involvement of healthcare providers as a barrier (Svendson et al. 2022) and express their preference for a blended approach with initial face-to-face sessions with physiotherapists (Button et al. 2018). These findings indicate that patients prefer face-to-face involvement of healthcare providers to be reassured and to develop confidence regarding the treatment provided. Therefore, considering patient preferences is essential in enhancing patient acceptance and use of DHI.

8.3.5.2 Physiotherapists' view

The preference of patients for other treatments can also be explained and supported from the perspectives of physiotherapists. In the quantitative phase (**Chapter 5, Figure 5**). The physiotherapists agreed with the statements that referring to the perceived usefulness of DHI; however, they revealed mixed views regarding the statement that DHI was compatible with a patient's needs. They provided a mix of opinions compared with their opinions regarding the other statements. This data suggests that while the physiotherapists perceived the effectiveness of digital interventions, they considered that such interventions were not compatible with the needs of patients. This quantitative data was supported by the interview data (**Chapter 7**); firstly, as described previously, DHI is unsuitable for all MSK conditions, which depends on several factors, such as patient preference for face-to-face treatment, cultural barriers, and the

absence of caregivers for older patients. All these factors, in addition to others, could potentially influence physiotherapists' ability to deliver DHI, as from their view is not suitable for all MSK patients. This finding is aligned with the findings of Bhattarai et al. (2020) and Parker et al. (2013) that DHI might not be suitable for patients of all conditions and age groups.

Furthermore, while physiotherapists perceived the effectiveness of DHI, their rate of agreement on regular usage was lower than that regarding their intended and expected use of DHI (**Chapter 5, Figure 9**). This indicates that other barriers may also contribute to this discrepancy. For instance, some of the physiotherapists in the current study showed their preference for face-to-face sessions over DHI. Despite recognising the potential benefits of DHI in improving patient outcomes and promoting self-management, physiotherapists continue to rely on traditional methods due to various factors. This concern can be demonstrated by the quantitative findings which showed some level of disagreement among the physiotherapists (21%) regarding the compatibility of using DHI with their professional needs (**Chapter 5, Figure 8**). This may be due to the need to change the work culture to move away from traditional practice to using DHI, as shown in **Chapter 7** where some physiotherapists noted some level of resistance to change in their work practices (**Chapter 7**). One of the significant factors that hindered physiotherapists from delivering DHI is the preference for interaction with patients during traditional treatment. This inclination may result from the physiotherapists' concern regarding the lack of proper communication while using DHI. This finding is also consistent with other studies that reported the lack of physiotherapist engagement in using DHI due to multiple factors (Button et al. 2018; Kloeck et al. 2020) and suggests that physiotherapists might still resist change in the management of their patients and can be a global issue and needs to be addressed adequately.

8.4 Knowledge contribution

As the first of its kind in Saudi Arabia, this study aimed to comprehend the DHI experience from the viewpoint of Saudi MSK patients and Saudi physiotherapists working in both public and private hospitals. The results provide a foundation for the demographic data of the patients and physiotherapists who utilised DHI in Saudi Arabia. These data can be used by the MOH and policymakers to address the factors that hinder both groups in DHI use. Because certain demographic groups could benefit more from DHI, targeting these groups and providing more focused interventions could enhance DHI engagement. Finally, the recommendations from the physiotherapists' perspectives represent end-user needs, and establishing these can potentially facilitate DHI uptake in Saudi Arabia. The UTAUT was utilised to collect survey data and the interview schedule to capture four constructs (e.g., performance expectancy, effort expectancy, social influences and facilitating conditions). It was also used during the interpretation of the interview findings, throughout the coding process and throughout the interpretation and integration of the findings for all phases of the discussion chapter. This approach provided a comprehensive view of the utilisation of DHI in Saudi Arabia under a well-established theoretical model. As the study was conducted in a country that values religion and culture, cultural factors were included as one construct to fill the gap in the cultural impact of DHI use among patients and physiotherapists in Saudi Arabia.

Regarding previous literature, the cultural factor was limited to privacy and trust from only the MSK patients' perspectives. The findings from the current thesis suggest that implementing strict measures to protect privacy and safety in DHI and ensuring that these interventions are delivered by authorised professional healthcare providers helps to alleviate any concerns about privacy and trust that patients expressed in previous studies. In addition, Ly et al. (2017) identified cultural factors related to religious beliefs that did not emerge in the current study

such as the negative impact of religious beliefs and the use of technology across the genders. The current study found DHI to be compatible with religious and cultural values, but the qualitative findings indicate that there are other sociocultural factors (**Chapter 7**) that could affect MSK patients in Saudi Arabia. Importantly, the Saudi female MSK patients revealed that DHI might not be compatible with their daily lives due to the impact of gender roles. Therefore, physiotherapists need to consider how to encourage DHI while balancing it with the daily lives of Saudi MSK patients, particularly females. The findings from the current thesis could guide future studies interested in exploring how cultural factors affect MSK patients during the adoption of DHI. The survey findings also provide an overview of the demographic data for both patients and physiotherapists that policymakers can use to develop strategies that enhance DHI uptake. To illustrate, female LBP or arthritis patients of more than one year with a bachelor's degree living in Makkah were the most common demographic of MSK patients engaging with DHI in this study. However, due to the short duration of DHI uptake and the high expected rating of percentage among these populations, recommendations were developed to address the gap in the literature. By considering these elements, this study has contributed to the knowledge of DHI use based on the demographic data of the participants, particularly in Saudi Arabia.

The UTAUT findings provided a comprehensive understanding of the patients' and physiotherapists' perspectives on using and delivering DHI. For example, patients' overall perceptions of the benefits of DHI use, its ease of use and its compatibility with culture and religion. However, some concerns negatively affected both groups, which could limit the regular usage of DHI by patients and physiotherapists. To illustrate this point further, while the majority of the MSK patients agreed regarding the availability of resources in the survey data (**Chapter 5**), the interviews revealed additional insights such as a lack of space in the patient's

home and a lack of equipment, emphasising potential barriers that need to be addressed. These barriers related to the environment, coupled with patients' beliefs regarding these obstacles, led to limited DHI engagement. Regarding physiotherapists, the lack of digital communication training was a significant factor that contributed to the knowledge gained in this study. It was found that communication training is needed along with intervention training, as previously discussed (Section 4). This reflected the strategies that physiotherapists should use to address these barriers and to provide approaches that could modify patients' beliefs.

The findings of the current thesis significantly expand the understanding of the factors that impact MSK patients' use and physiotherapists' delivery of DHI in Saudi Arabia by providing new insights into the impact of culture on enhancing or hindering patients' DHI use. By exploring previously unexamined aspects of physiotherapists' experiences in delivering DHI in real practice, this thesis also contributes information that enhances the current body of knowledge regarding physiotherapists' views and the impact of regulations and policies on their attitudes. The UTAUT explained under-researched dimensions within the field of technology, particularly in healthcare services. The data gathered in this thesis not only corroborate UTAUT theory but also introduce some valuable data that stimulate further enquiry. During the COVID-19 restrictions, the experiences of MSK patients and physiotherapists in real practice offered valuable insights that contributed to the knowledge. The interaction between the views of the MSK patients and physiotherapists was explored via multiple methods (i.e., survey and interview) and comparing the data with the scoping review revealed global barriers to DHI use. Additionally, the data are not limited to Saudi Arabia but can also represent a wider perspective of healthcare providers and MSK patients, who share similar factors globally. The organisational impacts, along with the MOH's regulations and policies, on physiotherapists' attitudes were found to be both positive and negative, as discussed previously (**Chapter 7**).

Notably, using the UTAUT as a theoretical framework to understand the factors that add valuable knowledge regarding DHI use by MSK patients and physiotherapists may have yet to capture the full scope of DHI use in Saudi Arabia. Personal preferences and environmental constraints are two examples of areas that are not part of the UTAUT. Merging these concepts with performance expectancy and facilitating condition constructs could enable future researchers to identify factors that hinder or facilitate DHI use, particularly for populations in similar contexts with similar cultural values. This could include adding the concept of environmental resources rather than focusing only on technical resources under the facilitating conditions construct. In addition, considering geographical places under facilitating conditions, particularly for rural areas and places with limited healthcare services, could expand this concept for those populations. Finally, for the effort expectancy construct, adding ease of communication with patients, particularly for the phenomena of healthcare services and using DHI, could be considered. This will add to the broader understanding of the usability of DHI under the most common factors that require further consideration by future researchers.

8.5 Strengths and limitations of the thesis

This study adopted a mixed methods approach due to the aim and research question and offers crucial insights into the current application of DHIs within MSK and physiotherapy practice in Saudi Arabia. It highlights a significant knowledge gap concerning DHI utilisation among these populations. It is essential to note the strength and limitations of using a mixed methods design in this research context, which will be briefly discussed.

8.5.1 Strengths of the thesis

The current thesis adopted a mixed-methods approach to provide a comprehensive understanding of the barriers and facilitators affecting the utilisation of DHI in Saudi Arabia. The strength of utilising a survey tool allowed the researcher to explore demographic data and describe the general use of DHI. It also gathered MSK patients' and physiotherapists' perceptions of DHI based on the UTAUT model and cultural factors. By conducting a cross-sectional design (phase I), I provided a general overview of the patients and physiotherapists who utilise DHI in Saudi Arabia and a general overview of the usage rate. This approach allowed me to capture a snapshot of current practices and attitudes towards DHI. Furthermore, using inductive and deductive coding procedures for qualitative interviews ensured a rigorous analysis of the experiences of MSK patients and physiotherapists with DHI in Saudi Arabia (Braun and Clark 2006).

Additionally, integrating data from different methods enhances the validity and broadens the understanding of factors influencing MSK patients' and physiotherapists' behaviour. Combining diverse sources of information (i.e., a scoping review, survey data and interview data) can give a more comprehensive perspective on the underlying causes and patterns that shape MSK patients' and physiotherapists' actions regarding DHI use, leading to more robust conclusions and insights. Moreover, integrating the UTAUT with cultural factors provided further in-depth information on factors from previously established theories that have been utilised frequently in different topics, even in the healthcare area (Venkatesh et al. 2003; Liu et al. 2014). Understanding the factors that could hinder or facilitate end-users' engagement with DHI seems complex, and no single study design could capture all the fundamental factors. The implications of this thesis's findings provide multiple factors that need to be addressed more

effectively, which can strengthen the findings, considering that multiple design approaches lead to different views for different participants.

8.5.2 Limitations

While sequential explanatory mixed methods design offers a comprehensive research approach, it also has limitations. As with any research work, mixed-methods studies may present unique obstacles and drawbacks precisely due to using multiple methods simultaneously. One potential drawback of mixed-methods studies is failing to unlock deep insights through individual methods used separately. Focusing solely on one method could allow researchers to gain more significant insights or make more in-depth observations in that approach. Researchers have argued against the paradigm conflict between qualitative and quantitative approaches, suggesting that each method has its strengths and can provide deep insights into specific aspects of research when used individually (Smith 1993; Wilkinson and Staley 2019). Single-method studies may offer deeper data analysis than mixed methods; however, their complex nature could limit the depth of data explored in this thesis.

Mixed-method studies may seem limited due to previously perceived drawbacks; however, it should consider that digital health adoption is highly multidimensional (Keel et al. 2022) and using only one research method may not present unique challenges when comprehending participant usage patterns. Dawadi et al. (2021) reveal that using mixed methods provides an advantage in understanding complex phenomena, which aligns with the nature of the current study. Thus, mixed methods may limit breadth over depth compared to single-method studies. However, they offer greater depth than single methods when exploring multifaceted phenomena like digital health adoption.

The current study encompasses all types of DHI available in healthcare services in Saudi Arabia and sought to explore the overall usage of DHI among MSK patients and physiotherapists. Including all DHI aligns with the study's objective and contributes to filling the existing gaps in the Saudi literature. Despite the benefits of including all types of DHI, such as detecting usage behaviour, it is important to acknowledge any potential limitations. This includes all of the DHI's limitations, insights into specific tools or aspects such as content and usability unique to certain types of DHI. Examining these factors could provide more nuanced insight into engagement with particular interventions and capture factors influencing their use. However, focusing on specific tools could limit the understanding of the general experiences of participants in Saudi Arabia. Therefore, while this approach was relevant to the current study's objectives, future research should focus on identifying barriers specifically related to individual types of DHIs.

It is important to note that this study primarily represents the perspectives of individuals who have experience of using technology, as per the inclusion criteria. It may not accurately reflect the opinions and experiences of those who do not use or have never used technology within a similar timeframe. This presents a significant limitation when considering the broader applicability and generalisability of these findings and may represent a biased view of the current findings for that population. Further research is needed to ensure the wider perspectives of relevant participants (e.g. male MSK participants, non-users for both MSK participants and physiotherapists).

The current study was conducted during the COVID-19 pandemic and within a period of restrictions which introduced potential limitations to the research, as illustrated in **Chapter 5**.

Conducting this study at a different time may have yielded results that differ from those of the current investigations. Furthermore, incorporating other methods such as paper-based and online surveys would help to ensure the representation of populations who are unfamiliar with technology.

8.6 Implications and recommendations

8.6.1 Implications and recommendations based on physiotherapists' perspectives.

The real-world challenges that physiotherapists face during clinical practice should be addressed, as they provide valuable insight from their practice. In the current thesis's findings, physiotherapists recommended providing features that could enhance the DHI tool and enhance patients' awareness of it to increase uptake, and they emphasised their need for further support from the organisation in Saudi Arabia. Indeed, the need to alter the features of DHI was consistent with previous studies. For example, in the current study, physiotherapists expressed the need to enhance interaction features. Including WhatsApp for communication was a typical application recommended by several physiotherapists for MSK patients. Kristjansdottir et al. (2011) found that providing voice feedback instead of written feedback and providing a history between patients and physiotherapists for written feedback were recommended. These are essential for settings and particular applications; therefore, enhancing DHI features might need to be more specific based on end-users' experiences.

As stated previously, the physiotherapists expressed the need for organisations to enhance patients' awareness of the benefits of DHI due to the lack of interest among MSK patients, highlighting their understanding of patients' needs. To address the impacts of low DHI use, increasing awareness among MSK patients, education and providing a campaign for the

general population could enhance patients' understanding and ultimate acceptance of DHI. It is also important to enhance peer support for sharing in established online groups so that physiotherapists can share their experiences, including the challenges they face during and after DHI delivery. Incorporating these recommendations into future development could enhance physiotherapists' experiences and ultimately improve DHI engagement. A lack of both training and guidelines negatively impacts physiotherapists' attitudes towards DHI; therefore, these factors should be considered by organisations, educators and researchers. Training is an essential factor that must be addressed by organisations, as it supports physiotherapists via peer support and workshops in their practice. A lack of training negatively impacts physiotherapists' attitudes, which is not limited to the current thesis's findings. Physiotherapists expressed their need for training and resources in recently published studies (Agnew et al. 2022; Kelly et al. 2022).

8.6.2 Implications and recommendations for the Ministry of Health and education

Both organisations and the MOH should provide sufficient training for physiotherapists. Specifically, workshops and practical training to enhance physiotherapists' understanding and delivery of DHI should be provided. In addition, the current thesis shows that communication is a critical aspect that influences patients. Therefore, organisations need to provide training specifically for effective communication via digital platforms that physiotherapists can use to enhance their ability to communicate effectively with MSK patients. Organisations should prioritise providing physiotherapists with specialised training tailored to their needs rather than providing general technology training. While understanding specific digital platforms is crucial, the findings of this study and recommendations from physiotherapists themselves suggest that customised training is vital. This approach ensures sufficient preparation and fosters a positive attitude towards DHI.

Training for effective digital communication should not be limited to physiotherapists working at the hospital. However, it should rather extend to those still studying at the university level to address the implications regarding education programmes provided to physiotherapists in Saudi Arabia. The curricula of physiotherapy education programmes should incorporate training related to the delivery of DHI to provide sufficient skills and knowledge regarding digital interventions, as this has become an essential part of healthcare delivery and one of the objectives of Saudi Vision 2030. In addition, this training should be practical and hands-on to allow students to gain experience in delivering DHI and to develop their communication skills when using a digital platform, considering web-based, mobile applications or other types of interventions.

8.6.3 Implications and recommendations for future researchers, organisations and policymakers

Organisations and researchers should consider the need for more guidelines and evidence-based practice for the effectiveness of the DHI among MSK patients. Researchers must conduct more studies in Saudi Arabia and other Middle Eastern countries, as limited studies regarding DHI among MSK patients are available. In addition, to address the limitations of the current research, it is crucial to consider potential differences between males and females who utilise DHI in Saudi Arabia to determine whether males face unique features or challenges with MSK and to understand comprehensive differences across genders. Furthermore, more research is needed to understand the cultural factors that hinder patients and physiotherapists in clinical practice, particularly for non-Saudi patients, and the language barriers due to communication through the DHI channel. In addition, the findings highlight the impact of gender roles on female participants; policymakers should consider gender-specific factors, particularly when

developing DHI. By addressing female participants' home responsibilities and balancing their healthcare needs, they will be able to utilise DHI more effectively.

One essential factor in the current thesis's findings is the impact of the organisational and governmental rules that were implemented during the COVID-19 pandemic. Although these rules had a positive impact on both participant groups, multiple barriers limited successful engagement with DHI, and regular use was low. Establishing similar rules could enhance patients' and physiotherapists' acceptance, but organisations need to establish guidelines and enhance the current features of DHI. Investments in DHI, as reported in the transformation to digitalisation document, will continue until we reach the mission of the Saudi 2030 Vision (MOH 2019). Enhancing DHI by providing standardised content with an improved visual appearance and videos to enhance its usability for MSK patients is recommended. Providing multiple communication methods and interactive features between MSK patients and physiotherapists in Saudi Arabia emphasises respect for the country's cultural context. Patients may not prefer to communicate with physiotherapists via video from a cultural point of view and Islamic values; this potentially respects the culture. As discussed above, more cultural factors should be considered among MSK patients regarding Islamic beliefs and Saudi customs. Therefore, policymakers who want to develop a specific DHI should consider this point, particularly for culturally sensitive countries.

Personalisation was highlighted in the literature as a facilitator and acknowledged the importance of utilising blended approaches as the preference for all participants (Kelly et al. 2022). Policymakers and the MOH in Saudi Arabia should recognise that offering blended approaches is based on individual needs and this can optimise MSK patients' satisfaction while maximising overall treatment effectiveness. Svendsen et al. (2022) provided personalised

treatment for LBP patients, but those patients still reported negative experiences due to various reasons, such as insufficient involvement of the healthcare provider. Therefore, there should be a balance between face-to-face sessions and other formats in the adoption of DHI to ensure patients' satisfaction with the treatment provided.

Regular evaluation of DHI should be conducted, as physiotherapists expressed the need to identify patients' satisfaction with their treatment providers. This can enhance their confidence and address any issues that patients might face during DHI adoption. Therefore, the MOH and other organisations should conduct regular evaluations of DHI to enhance patients' satisfaction and reach the goals of Vision 2030. Providing training on and evaluation of these alterations to amend regulations and policies will positively impact end users. Therefore, these recommendations are essential to guide future DHI expansion of different elements that need to be addressed these factors, as social influence could potentially be a significant factor for MSK patients and physiotherapists in Saudi Arabia.

8.7 Conclusion

This thesis' findings broaden our knowledge of factors affecting both MSK patients and physiotherapists in Saudi Arabia to use and deliver DHIs, offering new insights into how cultural and social factors either facilitate or impede using the DHI use for both populations. A mixed methods design captured the complexity of this topic which could not have been adequately addressed by a single method. The scoping review offers a global perspective on these factors, while the quantitative phase provides an overview of their utilisation, most commonly through mobile applications for follow-up care. This approach enabled to gain in-depth knowledge of literature and specific usage data about Saudi Arabian populations.

Examining previously unexplored aspects of physiotherapists' experiences when providing DHI in Saudi Arabia, this thesis adds vital insight to current knowledge regarding their perspective and the impact of regulations and policies on attitude formation. It can also provide insight regarding the cultural work-related factors of using DHI in healthcare globally and considering the current recommendations derived from the physiotherapists' views can reduce these factors. UTAUT is an invaluable theoretical framework highlighting areas for further investigation within healthcare services, particularly physiotherapy. This thesis presents data supporting UTAUT theory and new ideas. Insights from MSK patients and physiotherapists on their experiences during COVID-19 restrictions and scholarly evidence can provide valuable guidance on DHI strategies and their social impact. Although demographic representation in Saudi Arabia was limited in this study, its results offer valuable insight into prevalent usage patterns for DHIs.

Despite the positive attitude towards the use of the DHI among physiotherapists and patients with MSK conditions, certain factors were identified that limited the regular engagement with DHI. For instance, findings from the qualitative phase indicated a preference among patients for other treatments and this could be a significant barrier limiting patient engagement with the DHI. Although barriers were identified in the current study, both patients and physiotherapists rated their intentions and expectations highly and this suggests that addressing these barriers and enhancing the facilitating factors could lead to increased regular use of DHIs in future. Given the growing demand for such services, the expectations of both patients and physiotherapists need to be managed effectively. This can be achieved based on physiotherapists' recommendations, organisations require further work to enhance the uptake for both participants. These could involve campaigns demonstrating benefits associated with DHIs and organisational flexibility regarding regulations and policies encouraging more engagement from physiotherapists delivering such services to reduce any negative factors

related to work culture. Training programmes focusing on effective communication via digital platforms would also be essential and warrant further investigation to tailor training needs specifically catering towards physiotherapist requirements.

Considering the current thesis' findings, it becomes clear that embracing digital transformation is not just about adopting new technologies but adapting them effectively, ensuring they are accessible and beneficial for MSK patients and physiotherapists in Saudi Arabia. However, because this study only included users of DHIs, it may limit the insight into non-user populations and those who have yet to use technology. Therefore, future researchers should consider including these groups to gain a broader perspective of the factors that either hinder or facilitate the use of the DHI among physiotherapists and patients with MSK conditions. Furthermore, conducting similar studies at different timeframes could provide valuable insight beyond the influence of the COVID-19 pandemic and enhance the understanding of these factors. Considering all of these aspects would help to expedite DHI utilisation among such populations, particularly within Saudi Arabia, to achieve digitalisation by 2030, as outlined in Vision 2030 (Vision '2030' 2016).

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Appendices

Appendix I: JBI Critical Appraisal Tool

Qualitative research JBI critical appraisal tool.

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Note
Alego et al. (2017)	UC	UC	Y	UC	UC	UC	N	Y	Y	Y	There were no stated on the philosophical perspective and no exclusion criteria, and this might threat the internal validity of the study. As there was no philosophical perspective, it was not easy to know the congruity between the research methodology and the research objectives. The study aimed to identify the attitude, barrier and facilitators, and the data collection was a semi-structured interview which seems congruity with the aim of the study.
Battarai et al. (2020)	Y	UC	Y	Y	Y	UC	Y	Y	Y	Y	The sample was limited to the community of the Australian population, reduce the transparency of the finding to other population.
Battarai et al. (2020)	Y	Y	N	Y	Y	N	N	Y	Y	Y	Constructivism philosophical paradigm was utilised; however, data collection was applied for one place and not all professional healthcare has an experience of utilising the DHIs. Therefore, the is incongruence between the research constructivism and the data collection.
Cronstrom et al. (2019)	Y	Y	Y	UC	Y	N	Y	Y	UC	Y	Phenomenological philosophical paradigm was utilised, the state of the research position was reduced by using reflexivity, and separate data processing was applied between the two researchers. However, the experiences of the researcher works were not demonstrated.
Geraghty et al. (2019)	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	A convenience sample was adopted, while the aim to explore the experiences for a particular population who used self-back intervention. The result might not represent the target population. (Descriptive qualitative)
Ravn Jakobsen et al. (2018)	Y	Y	Y	Y	Y	UC	N	Y	N	Y	Giorgi descriptive phenomenological method, the study explores the experiences of the osteoporosis women after using an application to support self-management intervention. However, the aim of the study was not fully prescribed to the participants, which made the participants act only to see the result of bone density without understanding the self-management strategies. Also, no ethical approval was concealed; thus, a high judge of bias might occur due to this limitation.
Leese et al. (2019)	Y	UC	Y	Y	Y	N	N	Y	UC	Y	Constructivism, focus group, in-depth exploration of the patients and professional health carer perspective, nevertheless, not all participants have experiences of utilising Fitbit, and the author focuses mainly on this type of technology which limits the applicability to another type of technology.

Caiata Zufferey and Schulz(2019b)	Y	Y	Y	Y	Y	N	UC	Y	Y	Y	The author utilised a grounded theory which seems appropriate approach and the data analysis has been conducted in a precise with double coding, which enhances the rigour and trustworthiness of the finding. However, the role of the researcher was not clearly described, which might influence the finding of this study and convince sampling was used, which might not represent the population of utilising oneself intervention.
Parker et al. 2013	Y	UC	Y	Y	Y	NA	UC	Y	UC	Y	Focus group in-depth exploration, with the achievement of data saturation, however, an iphone4 was used and urban participants which limit the applicability and transferability of the finding to other population and other technology.
Zuidema et al. (2019)	UC	Y	UC	UC	Y	N	N	Y	Y	Y	No statement on philosophical orientation, weaken the result of this qualitative study.

JBIRandomised Control trail and Pilot study

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Note
Allen et al. 2018	Y	Y	Y	N	UC	Y	Y	Y	Y	Y	N	Y	Y	Other sources of bias might occur as the researcher provided patients with \$30 to complete the assessment, and this applies for each time of assessment period. The same type of assessment was applied; however, the delivery was different as the patient could not attend the site to fill the assessment, telephone-based was applied.
Bennel et al. 2017	Y	N	N	N	Y	UC	Y	Y	Y	Y	N	NA	Y	There was a difference between the two groups at the baseline, higher education level and longer duration of the symptoms. No statistic provides for the baseline to demonstrate if there is a significant difference between the groups to avoid confiding factors and to ensure the precise randomization process. One of the outcome measures was usability and the number of the completed questionnaire; however, the author provides a reward to complete the questionnaire, which weakens the validity of measuring the usability.
Hou et al 2020	Y	N	Y	N	Y	Y	Y	N	Y	Y	UC	Y	Y	A paper questionnaire was utilised during the outcome measure, which might impact on the reliable way to measure the participants.
Kloek et al. 2018	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	There was a clear description of the randomization sequence generation, concealed allocation and complete outcome measure. However, there was absent in the blinding for both patients, provider and assessor, which lead to the judge to high risk of bias. The dropout rate was high 15% at three months, and 35% at 12 months.
Trudeau et al. 2015	Y	Y	Y	N	UC	UC	Y	Y	Y	Y	Y	Y	Y	Gender and type of arthritis were the two main factors that generated in the randomization sequence—Association between the low-high user and the improvement of the outcome measures. There was a relation between the higher user and the communication with the physician. However, there was unclear, which cause, and the effect is.
ScHulz 2007	NA	NA	Y	NA	NA	NA	Y	Y	Y	Y	N	Y	Y	The outcome measures were applied by telephone questionnaire, which might impact the reliability of the finding. As this pilot study, the focusing was mainly on the attrition rate, and the number of participants was the same without any withdraw from the intervention.
Amorim et al. 2019	Y	Y	Y	N	Y	Y	UC	N	Y	N	N	Y	Y	No intention to treat, which increase the risk of attrition bias as 19% dropout from the study and the author failed to provide the reasons for loss to follow up, which was a critical component in the analysis of the risk of bias. Also, the

														weekly survey was not delivered for all participants due to technical issues, and this might enhance error in the statistical measurement and provide unreliable finding. Performance bias might occur as the control group did not integrate with professional healthcare providers, different than the intervention group. Several components were included in this study; therefore, the treatment effect cannot be attributed to the intervention.
Selter 2017	NA	NA	NA	NA	NA	NA	Y	N	NA	Y	Y	Y	N	No control group was available; however, this pilot study, therefore, many criteria for RCT was not applicable in this study. In addition, the author concludes that the engagement with the intervention was high; however, 38% has only completed the program. Therefore, the result should be taken with caution.
Geraghty 2018	Y	Y	N	Y	N	Y	Y	Y	NA	Y	Y	Y	Y	The pain level was not similar between the group and was higher in the intervention group, which might threat the internal validity of the study and high risk of selection bias.
Lorig et al. 2008	UC	UC	Y	N	N	N	Y	UC	Y	Y	Y	Y	Y	There was unclear how the randomization adopted; however, the author state that randomization was applied. In addition, the author provided a financial reward for participants. This might act as a bias because the data usage was collected as the number of participants completed the study. Therefore, caution must be taken when interpreted in this study.

JBI Quasi Experimental study

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Note
Zaslavsky 2018	Y	Y	UC	N	Y	UC	UC	N	Y	The attrition rate was reported, but there was no description of how the non-users were accounted for in data analysis. Thus, another risk of bias might be related. Also, the support was given for 14 weeks, and the intervention period was 19 weeks, this potentially cannot be attributed to the examined the full investigated intervention.

JBI Systematic review

Systematic review	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Note
Hewitt et al. (2020)	Y	Y	UC	UC	Y	Y	Y	Y	N	N	Y	Despite a comprehensive searching strategy, the author did not search for grey literature.

JBI Chorot study

Chorot pilot	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Note
Dahlberg et al 2016	NA	NA	Y	UC	Y	UC	Y	Y	NA	N	UC	Y	This study has a limitation of the missing control group as was essential in the cohort study. The Autor failed to identify the confounding factors as only age, sex, and BMI included. However, education, duration of illness was all critical confounding factors that might influence the finding.

Mixed method Tool (MMT)

MMT	Q1	Q2	Q3	Q4	Q5	Note
Button 2018	Y	Y	Y	N	N	The attrition rate was high, and there was no statistical analysis adopted. Also, there was no prediction for the confounders that might predict the outcome measure of utilising TRAK as this is a critical factor in the cohort study. Furthermore, the demographic data for the physiotherapist was absent, which might impact on the external validity of the study.
De Vries 2017	Y	Y	Y	UC	Y	Convergent mixed methods, there was unclear the philosophical based for qualitative type. As the quantitative was described roughly.
Eysenbah et al. 2016	Y	N	Y	UC	N	Small, simple size, the finding was limited to the private clinic worker. Adherence to the quality criteria for each method was poorly described for the interview and the feasibility test (questionnaire)
Kloek 2020	Y	Y	N	Y	N	In this study, a sequential mixed method was adopted. There was a clear explanation of both types of design. However, the interpretation of the output was limited as there was missing of explaining the characteristic of the physiotherapy when integrating to the qualitative part. Also, the quality of the quantitative part was low as there was no blinding for both participants and the assessors which threat the outcome results. There was unclear how the result of the quantitative part guides the selection of qualitative data source and data collection.
Najm 2020	UC	N	Y	UC	N	There was no statement on the type of mixed methods, that impact on the rationale of their study. In addition, despite the utilising international survey and enhancing the generalizability of the result, the first method was focussing group which was conducted on one country. This might threat the external validity and transferability of the result.
Mollard 2018	Y	Y	N	N	N	The quality of both types of methods has essential threats trustworthiness of the result. To illustrate, absent of randomization, concealed allocation, and blinding for both participants, assessors and delivers threat to the internal validity of the study, and risk of bias might occur. Also, the dropout rate was high, and there was no description of the process to understand the reason and the impact of these issues onto the research finding. Regarding the qualitative part, poorly reported the data analysis and no statement on the philosophical orientation that was based on the interview. Therefore, there was challenging to identify the congruent between the method and the data collection that was utilised.
Nordstoga et al. (2020)	Y	Y	N	N	N	Despite the strength of the combined two methods, the overall rating for this criterion based on two types of methods, lack of reflexivity, and this might indicate that researchers might influence the finding of this study. Also, the mhealth was accessible for Android only and this limit the generalizability of the study.
Sparks 2016	Y	N	Y	UC	N	The type of the taken the qualitative part was incongruent with the aim of the study, as the aim was to explore the experiences and the open-end question in the questionnaire was adopted to understand the patient's experiences. However, to understand the experiences, this type of methods could not give an in-depth understanding of the phenomena of experiences.
Kristjansdottir et al (2011)	UC	Y	UC	UC	N	There was unclear how data was collected, and there was no quotation for the interview method which threat the quality of the qualitative phase. However, there was a transparent randomization process; all the outcome measure was reported adequately, attrition bias was minimized by reporting the differences between the completers and non-completers. The results of this study should be taken with caution as a small sample size (6 female) and could not be generalized as it was a pilot study to understand the usability of the intervention.

Appendix II: Summary of studies

Authors	Name of DHI	Medium	Target MSK conditions	Details of DHI	Duration of the intervention
Allen et al.	Internet-based exercise training (IBET)	Web-based	Knee OA	IBET: • Video for exercises, • daily exercise (strengthening, stretching and aerobic exercise based on the recommendation) • Automated reminder for engagement • Tracking for progression of pain, function and exercise, tailed exercises which was based on the following measurement: • Pain • Function • Current activity	12 months
Alego et al. 2019	My Joint Pain	Digital self-management website	Arthritis	My Joint pain contain of: • Treatment and management options, Fact sheets, provide evidence-based information and type of treatment, such as exercises, weight loss and surgical treatment. • Health care providers, the place for the nearest professional healthcare to visit. • Watch and listen contain videos for narrative patient, and Treatment and fact sheets After registration, user management. One telephone follows up was applied after one week.	14 days
Bhattarai et al. 2020	RAISE	Mobile App	Arthritis	Rheumatoid Arthritis Information Support and Education (RAISE) app consisted of two measure part: • Assessment and documentations • Pain self-management education: medication, • Communication with healthcare professional • Exercise instruction pain related problem solving.	14 days
Bennel et al. (2019)	Internet delivered, physiotherapist prescribed home exercise and pain-coping skills training (PCST)	Web-based	Chronic knee pain	• 7 videoconferencing) skype session provided by physiotherapist for home exercises • 3 months access to PCST • Educational material. • Encouragement email.	9 months
Bossen et al. 2016	e-exercise	Web-based intervention	Knee or hip OA	E-exercise consist of: • 4 faces to face physical therapy session • 12 online assignments • Text-video based information • Promotion of Physical activities • Weekly automatic general exercises and physical activities Self-chosen based on time contingent manner.	12 weeks

Button et al.2018	TRAK	Website with links to YouTube video	Weight management patients, knee conditions	• YouTube videos help patients with daily exercises. • Education • Personalized plan • Blended approach where the website is to be used in conjunction with regular physiotherapy consultations.	3 months
Cronstrom et al. 2019	Joint Academy	Computable platform and can be worked on different medium (personal computers, mobile phone and Tablet)	Knee osteoarthritis	Joint Academy/ Web-based Osteoarthritis self-managing program, based on evidenced-based Consistent of: • 8 videos about OA, • self-management, coping strategies, • the impact of physical activity, exercises introduced in daily activity, • Chat to communicate with physiotherapy.	Six weeks
Dahlberg et al. 2016	Joint Academy	Computable platform and can be worked on different medium (personal computers, mobile phone and Tablet)	Knee osteoarthritis	Joint Academy/ Web-based Osteoarthritis self-managing program, based on evidenced-based Consistent of: • 8 videos about OA, • self-management, coping strategies, • the impact of physical activity, exercises introduced in daily activity, • Chat to communicate with physiotherapy.	6 weeks (supported by physiotherapist) 30 weeks without support.
De Vries et al. 2017	e-Exercise	Web-application intervention	Hip or Knee osteoarthritis	Three elements: • 5 faces to face physiotherapeutic sessions integrated with online web-application (both patients and physiotherapy have access to it) • 12-week physical activity program based on graded activity (assignments and goal setting) • Exercies(strength and stability exercises recommended by the physiotherapist with videos and text) • New Information related to the Osteoarthritis weekly (videos and text) Automatic tailored feedback based on the assignment completed.	3 months
Geraghty et al. 2019	Support Back	Web-based	LBP	Support back, which is an internet intervention, contained: • Tailored programme • goal setting, • feedback for encouraging the patient to be physically active. In addition, three physiotherapy telephone calls to provide reassurance.	Three months
Jakobsen et al. 2018	My Osteoporosis Journey	Mobile application, Smartphone and Tablet.	osteoporosis	My Osteoporosis Journey developed to use a bone density scan which provided by hospital, contain: • Education, • Treatment option, • Exercises. • Laboratory specialist sent the test information automatically to the app (written and graph of the DXA scan result) • Communication with GP (open end question.	4 weeks

- Sending message to the osteoporosis clinic at hospital.
- 12-week exercises programme, video,
- Advice for diet.
- Daily calculator intake of calcium and Vitamin D
- A reminder was optional to do exercise and take medicine and calculate intake of Calcium and Vitamin D.

Kloek et al. (2018)	eExercise	Online application	Knee or hip OA	5 faces to face session with physiotherapy which integrated with exercise application (graded activity, module for information, and exercise)	12 months
Kloek et al. 2020	eExercise	Online application	Knee or hip	• 5 face-to-face physiotherapeutic sessions integrated with online web-application (both patients and physiotherapy have access to it) • 12-week physical activity program based on graded activity (assignments and goal setting) • Exercises (strength and stability exercises recommended by the physiotherapist with videos and text) • New Information related to the Osteoarthritis weekly (videos and text) Automatic tailored feedback based on the assignment completed.	
Leese et al. 2019	Fitbit		OA	Physical activity tracker (Fitbit) Osteoarthritis Awareness Hub (OA-Hub) evidence-based online program, aim to guide informed decision-making • More than 2 months access	More than two months access
Mollard et al. 2018	LiveWith Arthritis	Mobile app	Hand Rheumatoid Arthritis	LiveWith Arthritis App, • Using optical image so the patient can monitor themselves. • Self-management behaviour was supported by measuring pain and providing treatment option, lifestyle and environmental data. • Patient can report and sharing this with the clinical provider.	6 months
Sparks et al. 2016	FibroGuide	DVD format	Fibromyalgia	FibroGuide, consist of 10 modules: • Understanding of fibromyalgia. • Communication with healthcare provider or family. • Being active. • Improving sleep. • Relaxing. • Coping with disease • Goal setting. • Pacing self. • Think differently. • Making time for self. • Weekly tracker Technical support, healthcare provider contact, reminder calls, email	12 weeks

Selter et al. 2018	Mhealth app	mobile application suite for both iOS and Android.	Chronic LBP	3 months physical therapy program and integrated Mhealth which include three daily visual self-reports: • Pain and activity level. • Medication • Video tutorials for rehabilitation • Activity level measurement passively • Chat with health coaching according to the patient need. • Personalised message to unfrequently interaction participants. • Weekly summary email	3 months
Zaslavsky et al. 2019	mhealth	Mobile health	Osteoarthritis	Activity tracker, personalised text and motivational interview	19 weeks
Zuferey et al. 2009	Onself	Web-based	LBP	Onself website included • Educational material (library) • The gym (video, pictures and description of the exercises) • Chat room (pt. can contact other pt., or professional health care rheumatologist and physiotherapist) • Testimonials (similar experiences)	6 months
Schulz et al. 2006	Onself	Web-based	LBP	Onself website included • Educational material (library) • The gym (video, pictures and description of the exercises) • Chat room (pt. can contact other pt., or professional health care rheumatologist and physiotherapist) • Testimonials (similar experiences)	6 months
Trudeau et al. 2015	PainAction	Web-based	OA	• Patient education • Self-management intervention • Communication with physician • Email reminder	6 months
Lorig et al. 2008	I-ASMP	Web-based	Arthritis and Fibromyalgia	• Module • Peer support • Email reminders • Tailored information • Education	One year

Hou et al. 2019	No specific name	Ehealth, a mobile phone-based	Patients after lumbar spinal surgery	• Patient and web-based interface for doctors. • Rehabilitation plan. • Video instructions • Daily report • Reminder to prompt the patients. • Doctors could see and alter the plan and have access to the patient's daily report. • Communication with the doctor through chat.	24 months
Amorim et al. 2019	Fitbit	Internet-based application and Fitbit and telephone support	LBP	• Face to face session • Tracker for physical activity through Fitbit • 12 telephone-based health coaching session	6 months
Zuidemia et al. 2019	No specific name	Online based program	RA	• An online dairy for pain and fatigue • Patient education ◆ Communication with professional health care ◆ Using assistive device ◆ Asking for help ◆ Balance of daily life ◆ Using medication	6 months
Nordstoga et al. 2020	SelfBack	Smartphone App and	CLBP	• Tailoring weekly plan: • Patients' education • Exercises • Physical activity	4 weeks
Kristjansdottir et al (2011)	No name available	Web-enable mobile phone based and CD	Chronic widespread pain	• Face to face meeting (one heure) • Goal setting and need for support • CBT Exercise • Question diaries feedback content (three per day/ 19-23 questions self-monitoring of thought and feelings) • CD (Relaxation and mindfulness exercise)	4 weeks

Appendix III: Ethical approval (1)



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Appendix IV: Ethical approval (2)



مديرية الشؤون الصحية بمحافظة الطائف
Directorate of Health Affairs - Taif
ادارة البحوث والدراسات
Research and Studies Department

' Ethical approval '

Up date

IRB Registration Number With KACST , KSA: **HAP-02-T-067**

Approval number : **537**

Date : **10/03/2021**

DEAR RESEARCHER`S

I am pleased to inform you submission dated (22.APR.2021) for the study titled , **(The barriers and facilitators when using Digital Health Intervention as a self-management approach by physiotherapists for patient with musculoskeletal conditions in the kingdom of Saudi Arabia: An explanatory sequential mixed methods study)**, was reviewed and was approved. please note that this approval is from the research ethics perspective only. you will still need to get permission from the manager of hospital or an external institution to commence data collection. we wish you well as you proceed with the study and request you to keep the IRB informed of the progress on a regular basis , using the IRB log number shown above. PLEASE BE ADVISED that regulations require that you submit a progress report on your research every 1 month, you are also required to submit any manuscript resulting from this research for approval by IRB before submission to journals for publication.

BEST REGARDS,,,,

TI
D STUDIES DEPARTMENT

Appendix V: Ethical approval (3)



مدينة سلطان بن عبد العزيز للخدمات الإنسانية
SULTAN BIN ABDULAZIZ HUMANITARIAN CITY

Date: 04/04/2021
IRB No.: 45-2021-IRB

To: **Ms. Roaa Sroge**
PI: "The barriers and facilitators when using Digital Health Intervention as a self-management approach by physiotherapists for patients with musculoskeletal conditions in the Kingdom of Saudi Arabia: An explanatory sequential mixed method study."
Cardiff University
E-mail: [REDACTED]

Subject: Approval for Research No. 41/PhD/2021
Study Title: "The barriers and facilitators when using Digital Health Intervention as a self-management approach by physiotherapists for patients with musculoskeletal conditions in the Kingdom of Saudi Arabia: An explanatory sequential mixed method study."
Study Code: 41/PhD/2021
Date of Approval: 01/04/2021
Date of Expiry: 01/06/2022
Board approval: All members of IRB

Dear **Ms. Sroge**,

Your Project has been approved and you have the permission to conduct this study following your submitted documents as follow:

1. Curriculum Vitae for the PI researcher
2. Letter from the researcher requesting SBAHC participation in the clinical study
3. Research proposal according to SBAHC IRB Guidelines
4. SBAHC Informed Consent Template
5. Research Obligatory Agreement. Available upon the completion of the other requirements
6. GCP Certificate

You are required to obey by the rules and regulations of the Government of Saudi Arabia, the SBAHC IRB Policies and procedures and the ICH-GCP guidelines. You have to note that this approval mandate responding to IRB's periodic request and surveillance result. Drawing your attention to the following:

- Amendment of the project with the required modification to providing Periodical report for this project specially when study extension is required or expiry before study completion
- All unforeseen events that might affect continued ethical acceptability of the project should be reported to the IRB as soon as possible

Appendix VI: Consent form (survey)



نموذج الموافقة (استبيان)

العوائق والميسرات عند استخدام التدخل الصحي الرقمي كنهج للإدارة الذاتية من قبل أخصائي العلاج الطبيعي والمرضى الذين يعانون من أمراض العضلات والعظام في المملكة العربية السعودية

الرجاء وضع الأحرف الأولى من اسمك ولقبك في كل مربع

- ☐ 1- أؤكد أنني قد قرأت ورقة المعلومات المؤرخة ٢٠٢١/٢/٠٣ للدراسة أعلاه وأتاحت لي الفرصة للنظر في المعلومات وطرح الأسئلة وحصلت على الإجابات بشكل مرض.
- ☐ 2- أفهم أن مشاركتي طوعية وأني حر في الانسحاب من الدراسة في أي وقت دون إبداء أي سبب وبدون تحيز.
- ☐ 3- أفهم أن جميع البيانات التي أقدمها ستعامل بسرية وأن جميع البيانات الشخصية ستكون مجهولة المصدر.
- ☐ 4- أوافق على أن أي معلومات أقدمها يمكن استخدامها في أي كتابة أو نشر أو عرض تقديمي حول الدراسة البحثية.
- ☐ 5- يمكنني تقديم بريدي الإلكتروني أو رقم الهاتف لتلقي دعوة للمراحل التالية.
-
- ☐ 6- أوافق على المشاركة في هذه الدراسة وأفهم أنني سأتلقي نسخة واحدة من هذه الموافقة الموقعة.

اسم المشترك	اليوم	التوقيع
اسم المشترك	اليوم	التوقيع

نسخه للمشارك: ونسخه يتم الاحتفاظ بها من قبل الباحث

Appendix VII: Consent form (interview)



نموذج الموافقة (للمقابلة)

العوائق والميسرات عند استخدام التدخل الصحي الرقمي كنهج للإدارة الذاتية من قبل أخصائي العلاج الطبيعي والمرضى الذين يعانون من أمراض العضلات والعظام في المملكة العربية السعودية

الرجاء وضع الحرف الأول من اسمك ومن لقبك في كل مربع

- ☐ 1- أؤكد أنني قد قرأت ورقة المعلومات المؤرخة ٢١/٠٣/٠٢ للدراسة أعلاه وأتحت لي الفرصة للنظر في المعلومات وطرح الأسئلة وحصلت على الإجابات بشكل مرض.
- ☐ 2- أفهم أن مشاركتي طوعية وأني حر في الانسحاب من الدراسة في أي وقت دون إبداء أي سبب وبدون تحيز.
- ☐ 3- أفهم أن جميع البيانات التي أقدمها ستعامل بسرية وأن جميع البيانات الشخصية ستكون مجهولة المصدر.
- ☐ 4- أوافق على التسجيل الصوتي لمشاركتي في المقابلة.
- ☐ 5- أوافق على أن أي معلومات أقدمها يمكن استخدامها في أي كتابة أو نشر أو عرض تقديمي حول الدراسة البحثية.
- ☐ 6- أوافق على المشاركة في هذه الدراسة وأفهم أنني سأتلقي نسخة واحدة من هذه الموافقة الموقعة.

اسم المشترك/ة	اليوم	التوقيع
اسم الباحثة	اليوم	التوقيع

نسخه للمشارك: ونسخه يتم الاحتفاظ بها من قبل الباحث

Appendix VIII: Participant information sheet (survey PT)



PARTICIPATION INFORMATION SHEET

Phase 1 Survey (Physiotherapist)

Exploring the barriers and facilitators experienced by physiotherapists and patients with musculoskeletal conditions when using Digital Health Interventions as a self-management approach in Saudi Arabia (Makkah and Taif).

Thank you for your interest in my research. Before you decide whether to participate, I would like to provide you with some information about the study and what your participation will involve. Please read the following information carefully, and if you have any queries, you can contact the researcher via the details at the end of this document.

1-What is the purpose of the study?

The purpose of this study is to explore the barriers and facilitators when using Digital Health Intervention (DHI) as a self-management approach among Musculoskeletal physiotherapists and patients in the Kingdom of Saudi Arabia. In phase 1, this survey will identify areas of interest which will be further explored in greater detail in the later phases.

2-What is a Digital Health Intervention?

DHI is the delivery of health information via a digital platform, such as a mobile phone or website. Using DHI physiotherapists can monitor and follow up patients with musculoskeletal problems to help them self-manage their condition.

3- Why have I been invited to take part in this research study?

You have been invited to participate in this study because you are a qualified physiotherapist working in a private, military, or public health hospital, and have used at least two-months experience using DHI with patients with musculoskeletal condition.

4- Is my participation compulsory?

No, your participation in this research project is entirely voluntary, and it is up to you to decide whether you take part. If you choose to do so, you will be asked to sign a consent form. If you decide not to take part, you do not have to explain your reason(s), and it will not affect your legal rights. You are free to withdraw your consent to participate in the research project at any point without providing a reason, even after signing the consent form. Also, there will be no impact on your clinical practice, whether or not you decide to take part in the current study.

5- What will taking part involve?

If you do decide to take part, you can read this sheet for three days and then you can send a message to the researcher for more information. You will need to sign a consent form, and then you will be provided a link for the online survey or (hard copy) which you will complete. Completing the survey will take approximately 10 minutes. The survey will be about your experience and your opinions on the use of a DHI. You can fill out the survey, at a convenient time for you. The online survey will be available from 01/05/2021 until 30/06/2021.

6- Will I be paid for taking part?

No, you will not be paid for taking part in the current study.

7- What are the possible benefits of participating in this study?

There will be no direct advantages or benefits to taking part in this study. Your contribution will help us understand the barriers or other factors of DHI. This will help improve the use of DHIs in the self-management of musculoskeletal conditions by informing the development of recommendations for the Kingdom of Saudi Arabia.

8- What are the possible risks of participation in this study?

There is limited risk associated with taking part in this study, as you will only have to fill out the survey. However, you may feel anxious after completing the survey. The researcher will support you and refer you to the line manager or the responsible person in your department to obtain the support you need. Eye strain may occur due to using a computer or other digital device, but this can be managed by taking a rest. Participants' well-being is considered necessary during this pandemic time; therefore, if you feel unwell or uncomfortable, you can complete the survey later.

9- How will the confidentiality of my participation be maintained?

All information collected from you during the research project will be treated with strict confidentiality and all participants in this phase of the study will be assigned a reference code. By doing this, the information you provide cannot be linked to any individual. All data will be kept in password protected folders and will only be accessed by the researcher and her supervisors. However, if the researcher identifies any information which might cause concern for your safety or well-being, the confidentiality of your data might be overridden and the information disclosed to the responsible authority, such as a line-manager or head of the department. Any personal information that you provide will be managed in accordance with the General Data Protection Legislation (GDPR).

10- What will happen to my personal data?

All information will be processed under the GDPR guidelines. That means any information related to the personal data (name, age, gender, email), will be protected under the Data Controller and Data protection Legislation of the Cardiff University. The data that will be gathered might be used for scientific purpose such as publication or another researcher output. The researcher will ensure that no information is published that would allow individuals to be identified. All personal data will be destroyed at the end of the study. For further information about Data Protection includes:

- your rights
- the legal basis under which Cardiff University processes your personal data for research
- Cardiff University's Data Protection Policy
- how to contact the Cardiff University Data Protection Officer
- how to contact the Information Commissioner's Office

may be found at <https://www.cardiff.ac.uk/public-information/policies-and-procedures/data-protection>

11- What will happen to the data at the end of the research project?

The data collected during this study will be analysed and presented in a thesis and any publication and presentation about the research. Only the supervisors and researcher will have access to the raw data. The researcher will ensure that all data will be anonymised, and participants will not be identifiable. The data of the study will be kept on a protected Cardiff university server and will be retained for a period of 5 years of completing this project; then, it will be deleted.

12- What if something goes wrong?

Necessary steps have been taken to prevent any foreseeable issues. However, if you have any complaints or concerns about this research, please contact me, Roaa Sroge (PhD student) at [REDACTED] or you may also contact the research supervisors [REDACTED] or [REDACTED] from the School of Healthcare Sciences at Cardiff University.

If you feel that your complaint was not handled to your satisfaction, you may also contact [REDACTED] or [REDACTED] of Research Governance, School of Healthcare Sciences, at [REDACTED] or at [REDACTED]

13- Who is conducting this study?

The research is conducted by Roaa Sroge (PhD student) and supervised by [REDACTED] [REDACTED] from the School of Healthcare Sciences at Cardiff University.

14- Who has reviewed the study?

This research project has been granted ethical approval by the School of Healthcare Sciences Research Ethics Committee, Cardiff University, private hospital and the Ministry of Health (Taif and Makkah).

15- Who do I contact for further information?

If you have any question related to the study, please do not hesitate to contact me Roaa Sroge (PhD student) via e-mail at: [REDACTED]

Thank you for considering taking part in this research project. If you decide to participate, you will be given a copy of this Participant Information Sheet and a signed consent form to keep for your record.

Appendix IX : Participant information sheet (interview PT)



PARTICIPATION INFORMATION SHEET Phase 2 Interview (Physiotherapist)

**Exploring the barriers and facilitators experienced by physiotherapists and patients with musculoskeletal conditions when using Digital Health Interventions as a self-management approach in Saudi Arabia
(Makkah and Taif)**

Thank you for your interest in my research. Before you decide whether to participate, I would like to provide you with some information about the study and what your participation will involve. Please read the following information carefully, and if you have any queries, you can contact the researcher via the details at the end of this document.

1-What is the purpose of the study?

The purpose of this study is to explore the barriers and facilitators when using Digital Health Intervention (DHI) as a self-management approach among Musculoskeletal physiotherapists and patients in the Kingdom of Saudi Arabia. In phase 2, this interview will explore the areas of interest that have been gathered during the online survey in detail.

2-What is a Digital Health intervention?

DHI is the delivery of health information via a digital platform, such as a mobile phone or website. Physiotherapist can monitor and follow up patient with musculoskeletal problems to help them self-manage their condition.

3- Why have I been invited to take part in this research study?

You have been invited to participate in this study because you are a qualified physiotherapist working in a private, military, or public health hospital, and have at least two-months experience using a DHI with patients with a musculoskeletal condition.

4- Is my participation compulsory?

No, your participation in this research project is entirely voluntary, and it is up to you to decide whether you take part. If you choose to do so, you will be asked to sign a consent form. If you decide not to take part, you do not have to explain your reason(s), and it will not affect your legal rights. You are free to withdraw your consent to participate in the research project at any point without providing a reason, even after signing the consent form. Also, there will be no impact on your clinical practice, whether or not you decide to take part in the current study.

5- What will taking part involve?

If you do decide to take part, you can read this sheet for three days and then you can send a confirmation message to the researcher. You will need to sign a consent form first and then you will participate in an online interview conducted over Zoom. This interview is expected to be conducted between August 2021 and September 2021. The interview will be audio recorded, and the recording will be kept for research purposes. The interview will last approximately 45 minutes and will be about your experiences and thoughts about the use of DHI in your practice. For privacy purposes, a link to a Zoom meeting room will be sent via e-mail, and an ID number password will be provided. Only you and the researcher will have access to this meeting room.

6- Will I be paid for taking part?

No, you will not be paid for taking part in the current study.

7- What are the possible benefits of participating in this study?

There will be no direct advantages or benefits to taking part in this study. Your contribution will help us understand the barriers or other factors of DHI. This will help improve the use of DHIs in the self-management of musculoskeletal conditions by informing the development of new guidelines for the Kingdom of Saudi Arabia.

8- What are the possible risks of participation in this study?

There is limited risk associated with taking part in this study. However, you may feel anxious during or after finishing the interview. The researcher will support you and refer you to the line manager or responsible person in your department for the support you need. Eye strain may occur due to using a computer or other digital device, but this can be managed by taking a rest. Participants' well-being is considered necessary during this pandemic time; therefore, you can tell the researcher to support you if you feel unwell or uncomfortable. The researcher can stop the interview if you want, and a time can be rescheduled.

9- How will the confidentiality of my participation be maintained?

All information collected from you during the research project will be treated with strict confidentiality and all participants in this phase of the study will be assigned a reference code. By doing this, the information you provide cannot be linked to any individual. All data will be kept in password protected folders and will only be accessed by the researcher and her supervisors. However, if the researcher identifies any information which might cause concern for your safety or well-being, the confidentiality of your data might be overridden and the information disclosed to the responsible bodies, such as a line-manager or head of the department. Any personal information that you provide will be managed in accordance with the General Data Protection Legislation (GDPR).

10- What will happen to my personal data?

All information will be processed under the GDPR guidelines. That means any information related to the personal data (name, age, gender, email), will be protected under the Data Controller and Data protection Legislation of the Cardiff University. The data that will be gathered might be used for scientific purpose such as publication or another researcher output. The researcher will ensure that no information is published that would allow individuals to be identified. All personal data will be destroyed at the end of the study. For further information about Data Protection includes:

- your rights
- the legal basis under which Cardiff University processes your personal data for research

- Cardiff University's Data Protection Policy
- how to contact the Cardiff University Data Protection Officer
- how to contact the Information Commissioner's Office

may be found at <https://www.cardiff.ac.uk/public-information/policies-and-procedures/data-protection>

11- What will happen to the data at the end of the research project?

The interview will be written up and a copy will be emailed to you. You will have 1 week to read and notify the researcher if there are any changes to be made. The information you provide will be analysed and presented in a thesis and shared via any publication or presentation about the research. All quotations and data will be anonymised via the use of pseudonyms. Only the supervisors and researcher will have access to the raw data. The data of the study will be kept on a protected Cardiff University server and will be retained for a period of 5 years of completing this project; then, it will be deleted.

12- What if something goes wrong?

Necessary steps have been taken to prevent any foreseeable issues. However, if you have any complaints or concerns about any aspect of this research, please contact me, Roaa Sroge (PhD student), at [REDACTED] or you may also contact the research supervisors [REDACTED] at [REDACTED] or [REDACTED] at [REDACTED] from the School of Healthcare Sciences at Cardiff University.

If you feel that your complaint was not handled to your satisfaction, you may also contact Dr. [REDACTED], Director of Research Governance, School of Healthcare Sciences, at [REDACTED] or at [REDACTED]

13- Who is conducting this study?

The research is conducted by Roaa Sroge (PhD student) and supervised by [REDACTED] [REDACTED] from the School of Healthcare Sciences at Cardiff University.

14- Who has reviewed the study?

This research project has been granted ethical approval by the School of Healthcare Sciences Research Ethics Committee, Cardiff University, private hospital and the Ministry of Health (Taif and Makkah).

15- Who do I contact for further information?

If you have any question related to the study, please do not hesitate to contact me Roaa Sroge (PhD student) via e-mail at [REDACTED]

Thank you for considering taking part in this research project. If you decide to participate, you will be given a copy of this Participant Information Sheet and a signed consent form to keep for your record.

Appendix X: Physiotherapists (survey)



Survey

Exploring the barriers and facilitators experienced by physiotherapists and patients with musculoskeletal conditions when using Digital Health Interventions as a self-management approach in Saudi Arabia (Makkah and Taif).

Thank you for your interest in my research and before you decide whether or not to complete the survey, please indicate your consent to complete the survey.

If you have any question related to the study, please do not hesitate to contact me Roaa Sroge (PhD student) via e-mail at: [REDACTED]

I voluntarily agree to take part in this research project (please tick the following box if you agree to participate) ☐ Agree

Section 1: Demographic questions

1-Please select your gender	☐ Male	☐ Female
2-Please indicate your age	☐ 25-35 ☐ 36-45 ☐ 46-55 ☐ more than 56	
3-Please indicate your city that you live in	☐ Riyadh ☐ Makkah ☐ Other	☐ Jeddah ☐ Taif
4-Please indicate your type of work	☐ Public hospital ☐ Private hospital ☐ Other.....	☐ Military hospital
5-Please indicate your level of education	☐ Bachelor's degree ☐ master's degree ☐ PhD degree ☐ Other	
6-Please indicate how many years have you been practicing your profession	☐ 0-5 years ☐ 10-20 years ☐ Other	☐ 5-9 Years ☐ >20 years

7- Type of employment

☐ Full time

☐ part time ☐ Other

Section 2: Types of DHIs and the level of support

8- Have you ever had training in order to use DHI in your practice?
Hours/days/ months

☐ Yes

☐ No

☐ I do not know

9. Please specify how many hours/days/
months

.....

10. What Digital Health intervention is already available in your practice? (Tick as many as apply).

☐ e-health

☐ Telehealth/Telerehabilitation

☐ self-management website

☐ mobile application

☐ m-health

☐ Other, namely

.....

11- Please indicate what integration strategy your organisation provided to offer DHI to your patient?

☐ Utilise a DHI as additional tool to support your patients.

☐ Utilise a DHI as a replacement to the session

☐ Utilise a DHI as a follow up and feedback tool

☐ Utilise a DHI as blended care (face to face session and DHI)

☐ Other, namely

.....

12. Please indicate what integration strategy do you think is the best way to utilise DHI in your practice? (You can choice more than one)

☐ Utilise a DHI as additional tool to support your patients.

☐ Utilise a DHI as a replacement to the session

☐ Utilise a DHI as a follow up and feedback tool

☐ Utilise a DHI as blended care (face to face session and DHI)

☐ Other, namely

.....

13.	Did you use any outcome measure to follow your patient during their treatment via DHI?	☐ Yes	☐ No	☐ I do not know
14.	What type of outcome measure did you used?			

Section 3: Adoption and use of DHI in the clinical practice

On a five-point scale, please tick the appropriate box that best represents your level of agreement with the following statements:

		Totally disagree	Partly disagree	Neutral	Partly agree	Totally agree
1-	Using DHI can increase my productivity in my work	☐	☐	☐	☐	☐
2-	The quality of the service that I provided to my patient can increase when I am using the DHI					
3-	Using DHI can enhance the quality and quantity of the outcome of my patients	☐	☐	☐	☐	☐
4-	Using DHI would enhance the relationship with my patients	☐	☐	☐	☐	☐
5-	I found that DHI easy to learn	☐	☐	☐	☐	☐
6-	I found the DHI easy to use	☐	☐	☐	☐	☐
7-	Using the DHI makes it easier to provide education/therapy/advice to my patients	☐	☐	☐	☐	☐
8-	My patients think that I should use the DHI with them	☐	☐	☐	☐	☐
9-	My organisation has supported the use of the DHI	☐	☐	☐	☐	☐
10-	Physiotherapist in my organisation who use the DHI have more prestige than other	☐	☐	☐	☐	☐
11-	I have the resources necessary to use the DHI	☐	☐	☐	☐	☐
12-	I have the skill to use DHI in my work	☐	☐	☐	☐	☐
13-	I have the knowledge necessary to use the DHI	☐	☐	☐	☐	☐
14-	I found someone available to help when I am experiencing any difficulties with DHI	☐	☐	☐	☐	☐
15-	Using DHI is compatible with my patient' needs	☐	☐	☐	☐	☐
16-	Using DHI is compatible with my religious aspects and cultural value	☐	☐	☐	☐	☐
17-	Using DHI is compatible with my needs	☐	☐	☐	☐	☐

18-	Using DHI fit with my daily life practice	☐	☐	☐	☐	☐
19.	People who influence my practice/behaviour think that I should use DHI	☐	☐	☐	☐	☐
20.	I believe that it is easy for the patient to use DHI and to perform what I want them to do	☐	☐	☐	☐	☐
21.	I am using DHI regularly	☐	☐	☐	☐	☐
22.	I intent to use the DHI	☐	☐	☐	☐	☐
23.	I expect to keep using DHI	☐	☐	☐	☐	☐

Add additional comments:

.....

Thank you for your time. Do not hesitate to contact the researcher.

Roaa Sroge (PhD Candidate)/ Email: [REDACTED]

Appendix XI : MSK patient (survey)



Survey

Exploring the barriers and facilitators experienced by physiotherapists and patients with musculoskeletal conditions when using Digital Health Interventions as a self-management approach in Saudi Arabia (Makkah and Taif).

Thank you for your interest in my research and before you decide whether or not to complete the survey, please indicate your consent to complete the survey.

If you have any question related to the study, please do not hesitate to contact me Roaa Sroge (PhD student) via e-mail at: [REDACTED]

I voluntarily agree to take part in this research project (please tick the following box if you agree to participate). ☐ Agree.

Section 1: Demographic questions

1-Please select your gender	☐ Male	☐ Female
2-Please indicate your age	☐ 18-25 ☐ 26-35 ☐ 36-45 ☐ 46-55 ☐ more than 56	
3-Please indicate your city that you live in	☐ Riyadh ☐ Jeddah ☐ Makkah ☐ Taif ☐ Other	
4-Please indicate your type of condition	☐ Low back pain ☐ Osteoarthritis ☐ Other.....	☐ Arthritis
5-Please indicate your level of education	☐ Primary school ☐ High school ☐ Diploma ☐ Other	☐ Bachelor's degree ☐ Master's degree ☐ PhD degree

6-Please indicate for how long you suffer from your condition

- ☐ 0-3 months ☐ 4-6 months ☐ 7-12 months
☐ more than one year

Section 2: Types of DHIs and the level of support

7. What type of technology has you already used in the treatment with your physiotherapist? (Tick as many as apply)	☐ Mobile application ☐ Website ☐ Website with telephone support from physiotherapist ☐ Website with mobile application ☐ Website with telephone support from physiotherapist and with mobile application ☐ Website with face-to-face physiotherapist session ☐ Other, namely
8. Have you received any instructions about how to use DHI?	☐ Yes ☐ No ☐ I do not know
9. Please specify for how long period you have received any instructions about how to use digital health intervention?	
10. Please indicate for how many months did you used a DHI.	☐ 2-months ☐ 5-7 months ☐ 3-4 months ☐ 8-12 months ☐ Other
11. Please indicate what the way that you received to use a digital health intervention with physiotherapist?	☐ using a DHI as additional educational tool to support you. ☐ using a DHI as a replacement to the session ☐ using a DHI as a follow up and feedback tool ☐ using a DHI as blended care (face to face session and DHI) ☐ Other, ...
12. Please indicate what the best way to use a digital health intervention with physiotherapist?	☐ using a DHI as additional educational tool to support you. ☐ using a DHI as a replacement to the session ☐ using a DHI as a follow up and feedback tool ☐ using a DHI as blended care (face to face session and DHI) ☐ Other, ...

Section 3: Adoption and use of DHI in the clinical practice

13-On a five-point scale, please tick the appropriate box that best represents your level of agreement with the following statements:

		Totally disagree	Partly disagree	Neutral	Partly agree	Totally agree
1-	Using digital health intervention helpful in achieving my treatment goals	☐	☐	☐	☐	☐
2-	Using digital health intervention useful in managing my health condition	☐	☐	☐	☐	☐
3-	Using digital health interventions enhance the effectiveness of the treatment that provided by physiotherapist	☐	☐	☐	☐	☐
4-	Using digital health intervention enhance my awareness of my health condition	☐	☐	☐	☐	☐
5-	I found digital health intervention easy to use	☐	☐	☐	☐	☐
6-	I found it easy to customize exercises and information when using digital health intervention	☐	☐	☐	☐	☐
7-	Using digital health intervention makes it easier to receive therapy from the physiotherapist	☐	☐	☐	☐	☐
8-	I believe that it is easy to do what a physiotherapist wants me to do when using digital health intervention	☐	☐	☐	☐	☐
9-	My family/friends believe that I should use digital health intervention	☐	☐	☐	☐	☐
10-	My physiotherapist believe that I should use digital health intervention	☐	☐	☐	☐	☐
11-	Using a digital health intervention would enhance the relationship with a physiotherapist	☐	☐	☐	☐	☐
12-	People around me who use digital health intervention have more prestige than those who do not	☐	☐	☐	☐	☐
13-	I have the resources necessary to use digital health intervention	☐	☐	☐	☐	☐
14-	I found someone available to help when I am experiencing any difficulties with digital health intervention	☐	☐	☐	☐	☐
15-	I have the knowledge to use a digital health intervention	☐	☐	☐	☐	☐

16-	I have the skill to use digital health intervention	☐	☐	☐	☐	☐
17-	I found the use of digital health interventions fit into my daily life	☐	☐	☐	☐	☐
18.	Using digital health intervention is appropriate with my needs	☐	☐	☐	☐	☐
19.	Using digital health interventions compatible with Saudi customs and values	☐	☐	☐	☐	☐
20.	Using digital health intervention is compatible with the Islamic tradition	☐	☐	☐	☐	☐
21.	I am using digital health intervention regularly	☐	☐	☐	☐	☐
22.	I intent to use digital health interventions	☐	☐	☐	☐	☐
23.	I expect to keep using the digital health intervention technique	☐	☐	☐	☐	☐

Add additional comments:

.....

.....

Thank you for your time. Do not hesitate to contact the researcher.

Roaa Sroge (PhD Candidate)/ Email: [REDACTED]

Appendix XII: Arabic survey for patients



استبيان

العوائق والميسرات عند استخدام التدخل الصحي الرقمي كنهج للإدارة الذاتية من قبل أخصائي العلاج الطبيعي والمرضى الذين يعانون من أمراض العضلات والعظام في المملكة العربية السعودية

شكراً لك على اهتمامك ببحثي وقبل أن تقرر ما إذا كنت ستكمل الاستبيان أم لا، يرجى الإشارة إلى موافقتك على إكمال الاستبيان إذا كان لديك أي سؤال يتعلق بالدراسة، من فضلك لا تتردد في الاتصال بي رؤى سروجي (طالبة دكتوراه) عبر

البريد الإلكتروني:



أوافق طواعية على المشاركة في هذا المشروع البحثي (يرجى وضع علامة في المربع التالي إذا كنت توافق على المشاركة).

☐ موافق.

الجزء الأول: أسئلة عامة

-الرجاء تحديد جنسك "ذكر" أنثى "آخر

☐ أنثى

☐ ذكر

1-الرجاء تحديد

جنسك

2-الرجاء تحديد عمرك

١٨-٢٥ ☐ ٢٦-٣٥ ☐ ٣٦-٤٥ ☐

٤٦-٥٥ ☐ أكثر من ٥٦ ☐

3-يرجى تحديد مدينتك التي تعيش

الرياض ☐ مكة ☐

☐ أخرى

فيها

جدة ☐ الطائف ☐

4-الرجاء تحديد مستواك التعليمي

ابتدائي ☐ متوسط ☐

درجه الماجستير ☐ أخرى ☐

ثانوي ☐ جامعي ☐

درجه الدكتوراه ☐

5-الرجاء تحديد

هشاشه العظام ☐ آلام اسفل الظهر ☐

حالتك الصحية

التهاب المفاصل ☐ أخرى ☐

- 6-كم من الوقت ☐ ٣-٠ أشهر ☐ ٦-٤ أشهر
- تعاين من حالتك ☐ ١٢-٧ أشهر ☐ أكثر من سنة

الجزء الثاني: أنواع تقنيه التدخل الصحي الرقمي ومستوى الدعم

- 7-ما نوع التدخل الصحي الرقمي التي استخدمتها في العلاج مع أخصائي العلاج الطبيعي
(يمكنك اختيار أكثر من إجابة)
- ☐ تطبيق في الهاتف المحمول
- ☐ موقع إلكتروني مع تطبيق جوال
- ☐ موقع إلكتروني
- ☐ موقع إلكتروني مع جلسة علاج طبيعي وجهاً لوجه
- ☐ موقع إلكتروني مزود بدعم عبر الهاتف من أخصائي العلاج الطبيعي
- ☐ موقع إلكتروني مزود بدعم عبر الهاتف من أخصائي العلاج الطبيعي وتطبيقات الهاتف المحمول
- ☐ أخرى

- 8- هل تلقيت أي تعليمات حول كيفية استخدام التدخل الصحي الرقمي؟
- ☐ نعم ☐ لا ☐ لا أعلم

- 9- إذا تلقيت تعليمات حول كيفية استخدام التدخل الصحي الرقمي يرجى تحديد المدة (ساعات-أيام-شهور)
-

□ ٠ - شهرين

10- الرجاء تحديد عدد الأشهر الذي تم

□ ٣-٤ أشهر

استخدام التدخل الصحي الرقمي؟

□ ٥-٧ أشهر

□ ٨-١٢ شهر

□ أكثر من سنة

□ استخدام تقنية التدخل الصحي

11-الرجاء تحديد الطريقة التي استخدمت

□ استخدام تقنية التدخل الصحي الرقمي كبديل لجلسه العلاج

فيها التدخل الصحي الرقمي مع أخصائي

العلاج الطبيعي

الطبيعي الرقمي كأداة تعليمية إضافية

□ استخدام تقنية التدخل الصحي كأداة للمتابعة وإعطاء الملاحظات

من قبل أخصائي العلاج الطبيعي.

□ استخدام تقنية التدخل الصحي مدمج مع جلسة العلاج الطبيعي

(جلسات علاج طبيعي ومتابعه عن طريق التقنية)

□ أخرى

.....

الجزء الثالث: اعتماد واستخدام التدخلات الصحة الرقمية

12- على مقياس مكون من خمس نقاط، يرجى تحديد المربع المناسب الذي يمثل أفضل مستوى من موافقتك على العبارات

التالية:

أتفق بشده	أتفق	لا أتفق بشده	لا يوجد رأي محدد	لا أتفق	لا أتفق بشده
□	□	□	□	□	□
□	□	□	□	□	□
□	□	□	□	□	□
□	□	□	□	□	□
□	□	□	□	□	□

☐	☐	☐	☐	☐	6 - لقد وجدت أنه من السهل تخصيص التمارين والمعلومات عند استخدام التدخل الصحي الرقمي
☐	☐	☐	☐	☐	7 - إن استخدام التدخل الصحي الرقمي يجعل من السهل تلقي العلاج من أخصائي العلاج الطبيعي
☐	☐	☐	☐	☐	8 - أعتقد أنه من السهل أن أفعل ما يريدني أخصائي العلاج الطبيعي أن أفعله عند استخدام التدخل الصحي الرقمي
☐	☐	☐	☐	☐	9 - أهلي/أصدقائي يعتقدون أنه على أن استخدم التدخل الصحي الرقمي
☐	☐	☐	☐	☐	0 1 - يعتقد أخصائي العلاج الطبيعي أنه يجب على استخدام التدخل الصحي الرقمي
☐	☐	☐	☐	☐	11- من شأن استخدام التدخل الصحي الرقمي أن يعزز العلاقة مع أخصائي العلاج الطبيعي
☐	☐	☐	☐	☐	12- الأشخاص من حولي الذين يستخدمون التدخل الصحي الرقمي يتمتعون بمكانة أكبر من أولئك الذين لا يفعلون ذلك
☐	☐	☐	☐	☐	13- لدي الموارد اللازمة لاستخدام التدخل الصحي الرقمي
☐	☐	☐	☐	☐	14- أجد شخصًا متاحًا للمساعدة عندما أواجه أي صعوبات في التدخل الصحي الرقمي
☐	☐	☐	☐	☐	15- لدي المعرفة لاستخدام التدخل الصحي الرقمي
☐	☐	☐	☐	☐	16- لدي المهارة لاستخدام التدخل الصحي الرقمي
☐	☐	☐	☐	☐	17- لقد وجدت أن استخدام التدخلات الصحية الرقمية يتناسب مع حياتي اليومية
☐	☐	☐	☐	☐	18- استخدام التدخل الصحي الرقمي مناسب لاحتياجاتي
☐	☐	☐	☐	☐	19- استخدام التدخلات الصحية الرقمية متوافق مع العادات والتقاليد السعودية
☐	☐	☐	☐	☐	20- استخدام التدخل الصحي الرقمي يتوافق مع التقاليد الإسلامية
☐	☐	☐	☐	☐	21- أستخدم التدخلات الصحية الرقمية بانتظام
☐	☐	☐	☐	☐	أتوقع الاستمرار في استخدام التدخلات الصحية الرقمية-22
☐	☐	☐	☐	☐	23-أنوي الاستمرار في استخدام التدخلات الصحية الرقمية

- 13- من خلال خبرتك السابقة ماهي أنسب طريق؛ ☐ استخدام تقنيه التدخل الصحي الطبيعي
- لاستخدام التدخل الصحي الرقمي مع أخصائي العلاج الطبيعي (يمكنك اختيار أكثر من إجابة)
- ☐ استخدام تقنيه التدخل الصحي الرقمي كبديل لجلسه العلاج الطبيعي الرقمي كأداة تعليمية إضافية
- ☐ استخدام تقنيه التدخل الصحي كأداة للمتابعة وإعطاء الملاحظات من قبل أخصائي العلاج الطبيعي.
- ☐ استخدام تقنيه التدخل الصحي مدمج مع جلسة العلاج الطبيعي (جلسات علاج طبيعي ومتابعه عن طريق التقنيه)
- ☐ أخرى

.....

14- إضافة تعليقات إضافية؟

شكرا لوقتكم، لا تتردد في الاتصال بالباحثة، رؤى سروجي (طالبة دكتوراه) البريد الإلكتروني:



Appendix XIII : Recruitment of participants via QR code



You are invited to participate in this study:

Exploring the barriers and facilitators experienced by physiotherapists and patients with musculoskeletal conditions when using Digital Health Interventions as a self-management approach in Saudi Arabia (Makkah and Taif).

You have been invited to participate in this study because you are 18 years or older and a patient suffering from any type of Musculoskeletal conditions and have used a DHI with support from a physiotherapist. You can scan the QR code for the information of the study and if you are happy to take part you can scan the QR for the online consent and the survey.

Participant Information Sheet:



Online consent and Survey:



Thank you for your time.

Appendix XIV: Arabic participant information sheets for patients (survey)



ورقة معلومات المشاركة

١

العوائق والميسرات عند استخدام التدخل الصحي الرقمي كنهج للإدارة الذاتية من قبل أخصائي العلاج الطبيعي والمرضى الذين يعانون من أمراض العضلات والعظام في مدينتي الطائف ومكة المكرمة العربية السعودية

شكرا لك على اهتمامك ببحثي. قبل أن تقرر ما إذا كنت ستشارك، أود أن أقدم لك بعض المعلومات حول الدراسة وما ستشمله مشاركتك. يرجى قراءة المعلومات التالية بعناية، وإذا كان لديك أي استفسارات، يمكنك الاتصال بالباحث عبر التفاصيل الموجودة في نهاية هذا المستند.

1- ما هو الغرض من الدراسة؟

الغرض من هذه الدراسة هو استكشاف العوائق والميسرات عند استخدام التدخل الصحي الرقمي كنهج للإدارة الذاتية بين أخصائي العلاج الطبيعي ومرضى العظام والمفاصل في المملكة العربية السعودية. في المرحلة الأولى، سيحدد هذا المسح مجالات الاهتمام التي سيتم استكشافها بمزيد من التفصيل في المراحل اللاحقة.

2- ما هو التدخل الصحي الرقمي؟

التدخل الصحي الرقمي هو إيصال المعلومات الصحية عبر منصة رقمية، مثل الهاتف المحمول أو موقع الويب. يمكن باستخدام أخصائي العلاج الطبيعي مراقبة ومتابعة المرضى الذين يعانون من مشاكل في العضلات والعظام لمساعدتهم على إدارة حالتهم عن بعد بأنفسهم.

3- لماذا تمت دعوتي للمشاركة في هذه الدراسة البحثية؟

لقد تمت دعوتك للمشاركة في هذه الدراسة لأنك تبلغ من العمر 18 عامًا أو أكثر ولأنك مريض يعاني من أي نوع من أمراض الجهاز العضلي الهيكلي وقد استخدمت التدخل الصحي الرقمي بدعم من أخصائي العلاج الطبيعي.

4- هل مشاركتي إجبارية؟

لا، مشاركتك في هذا المشروع البحثي تطوعية تمامًا، والأمر متروك لك لتقرر ما إذا كنت ستشارك أم لا. إذا اخترت القيام بذلك، سيُطلب منك التوقيع على نموذج موافقة. إذا قررت عدم المشاركة، فلا يتعين عليك توضيح السبب (الأسباب) الخاصة بك، ولن يؤثر ذلك على حقوقك القانونية. لك مطلق الحرية في سحب موافقتك على المشاركة في مشروع البحث في أي وقت دون إبداء أي سبب، حتى بعد التوقيع على استمارة الموافقة. أيضًا، لن يكون هناك أي تأثير على رعايتك السريرية، سواء قررت المشاركة في الدراسة الحالية أم لا.

5- ماذا ستشمل المشاركة؟

إذا قررت المشاركة، يمكنك قراءة هذه المعلومات وبعد ذلك يمكنك إرسال رسالة إلى الباحث للاستفسار عن أي معلومات إضافية. يمكنك عمل مسح بالجوال للاستبيان بإبداء موافقتك على المشاركة، وبعد ذلك يمكنك تعبئة الاستبيان. سيستغرق إكمال الاستبيان حوالي 10 دقائق. سيكون الاستطلاع حول تجربتك وآراء حول استخدام التدخل الصحي الرقمي. يمكنك ملء الاستبيان في الوقت المناسب لك. سيكون المسح متاحًا من ١/٠٤/٢٠٢١ حتى ٣٠/٠٥/٢٠٢١

6- هل سأدفع مقابل المشاركة؟

لا، لن يتم الدفع لك مقابل المشاركة في الدراسة الحالية.

7- ما هي الفوائد المحتملة للمشاركة في هذه الدراسة؟

لن تكون هناك مزايا أو فوائد مباشرة للمشاركة في هذه الدراسة. ستساعدنا مساهمتك على فهم العوائق أو العوامل الأخرى في التدخل الصحي الرقمي. سيساعد هذا في تحسين استخدام التدخل الصحي الرقمي في الإدارة الذاتية لأمراض الجهاز العضلي الهيكلي من خلال الإبلاغ عن وضع توصيات جديدة للمملكة العربية السعودية.

8- ما هي المخاطر المحتملة للمشاركة في هذه الدراسة؟

ليس هناك مخاطر محدودة مرتبطة بالمشاركة في هذه الدراسة، حيث سيتعين عليك فقط ملء الاستبيان. ومع ذلك، قد تشعر بالقلق بعد إكمال الاستبيان. سيدعمك الباحث ويحيلك إلى أخصائي العلاج الطبيعي للحصول على الدعم الذي تحتاجه. قد يحدث إجهاد العين بسبب استخدام جهاز كمبيوتر أو جهاز رقمي آخر، ولكن يمكن التحكم في ذلك عن طريق أخذ قسط من الراحة. تعتبر رفاهية المشاركين ضرورية خلال هذه الفترة الوبائية؛ لذلك، إذا شعرت بتوَعك أو عدم ارتياح، يمكنك إكمال الاستبيان لاحقًا.

9- كيف سيتم الحفاظ على سرية مشاركتي؟

سيتم التعامل مع جميع المعلومات التي تم جمعها منك خلال المشروع البحثي بسرية تامة وسيتم تخصيص رمز مرجعي لجميع المشاركين في هذه المرحلة من الدراسة. من خلال القيام بذلك، لا يمكن ربط المعلومات التي تقدمها بأي فرد. سيتم الاحتفاظ بجميع البيانات في مجلدات محمية بكلمة مرور ولن يتم الوصول إليها إلا من قبل الباحثة ومشرفيها. ومع ذلك، إذا حدد الباحث أي معلومات قد تسبب قلقاً على سلامتك أو رفاهيتك، فقد يتم تجاوز سرية بياناتك، ويتم الكشف عن المعلومات للسلطة المسؤولة مثل أخصائي العلاج الطبيعي المسؤول. ستتم إدارة أي معلومات شخصية تقدمها وفقاً للتشريع العام لحماية البيانات (GDPR).

10- ماذا سيحدث لبياناتي الشخصية؟

ستتم معالجة جميع المعلومات وفقاً لإرشادات اللائحة العامة لحماية البيانات. هذا يعني أن أي معلومات تتعلق بالبيانات الشخصية (الاسم، والعمر، والجنس، والبريد الإلكتروني)، ستتم حمايتها بموجب قانون حماية البيانات وقانون حماية البيانات في جامعة كارديف. قد يتم استخدام البيانات التي سيتم جمعها لأغراض علمية مثل النشر أو ناتج باحث آخر. سيضمن الباحث عدم نشر أي معلومات من شأنها أن تسمح بتحديد هوية الأفراد. سيتم حذف جميع البيانات الشخصية في نهاية الدراسة. لمزيد من المعلومات حول حماية البيانات، تشمل:

-حقوقك

- الأساس القانوني الذي بموجبه تقوم جامعة كارديف بمعالجة بياناتك الشخصية للبحث

- سياسة حماية البيانات بجامعة كارديف

- كيفية الاتصال بمسؤول حماية البيانات بجامعة كارديف

- كيفية الاتصال بمفوض المعلومات

يمكن العثور عليها <https://www.cardiff.ac.uk/public-information/policies-and-procedures/data-protection>

11- ماذا سيحدث للبيانات في نهاية المشروع البحثي؟

سيتم تحليل البيانات التي تم جمعها خلال هذه الدراسة وتقديمها في أطروحة وأي منشور وعرض تقديمي حول البحث. سيتمكن المشرفون والباحث فقط من الوصول إلى البيانات الأولية. سيضمن الباحث أن جميع البيانات ستكون مجهولة المصدر، ولن يتم التعرف على المشاركين. سيتم الاحتفاظ ببيانات الدراسة على خوادم محمية بجامعة كارديف وسيتم الاحتفاظ بها لمدة 5 سنوات من إكمال هذا المشروع؛ بعد ذلك، سيتم حذفه.

12- ماذا لو حدث خطأ ما؟

تم اتخاذ الخطوات اللازمة لمنع أي مشاكل متوقعة. ومع ذلك، إذا كانت لديك أي شكاوى أو مخاوف بشأن هذا البحث، فيرجى الاتصال بي، رؤى سروجي (طالبة دكتوراه) على [REDACTED] أو يمكنك أيضاً الاتصال بمشرفي الأبحاث [REDACTED]، على [REDACTED] أو [REDACTED] على [REDACTED] من كلية علوم الرعاية الصحية بجامعة كارديف.

إذا شعرت أنه لم يتم التعامل مع شكواك على نحو يرضيك، فيمكنك أيضاً الاتصال [REDACTED]، مدير إدارة البحوث، كلية علوم الرعاية الصحية، على [REDACTED] أو على [REDACTED]

13- من يقوم بهذه الدراسة؟

سيتم إجراء البحث من قبل رؤى سروجي (طالبة دكتوراه) وسوف يتم الاشراف عليها من قبل [REDACTED] من كلية علوم الرعاية الصحية بجامعة كارديف.

14- من قام بمراجعة الدراسة؟

تم منح هذا المشروع البحثي الموافقة الأخلاقية من قبل لجنة أخلاقيات البحث في كلية علوم الرعاية الصحية، جامعة كارديف، وسيتم اخذ الموافقة الأخلاقية من قبل وزاره الصحة لمنطقة الطائف ومكة في المملكة العربية السعودية.

15- بمن اتصل لمزيد من المعلومات؟

إذا كان لديك أي سؤال يتعلق بالدراسة، من فضلك لا تتردد في الاتصال بي رؤى سروجي (طالبة دكتوراه) عبر البريد الإلكتروني على: [REDACTED]

شكراً لك على التفكير في المشاركة في هذا المشروع البحثي. إذا قررت المشاركة، فسيتم إعطاؤك نسخة من صحيفة معلومات المشارك هذه واستمارة موافقة موقعة للاحتفاظ بها في سجلك.

Appendix XV: Arabic participant information sheets for patients (interview)

ورقة معلومات المشاركة



٢

العوائق والميسرات عند استخدام التدخل الصحي الرقمي كنهج للإدارة الذاتية من قبل أخصائي العلاج الطبيعي والمرضى الذين يعانون من أمراض العضلات والعظام في مدينتي الطائف ومكة المكرمة العربية السعودية

شكرا لك على اهتمامك ببحثي. قبل أن تقرر ما إذا كنت ستشارك، أود أن أقدم لك بعض المعلومات حول الدراسة وما ستشمله مشاركتك. يرجى قراءة المعلومات التالية بعناية، وإذا كان لديك أي استفسارات، يمكنك الاتصال بالباحث عبر التفاصيل الموجودة في نهاية هذا المستند.

1- ما هو الغرض من الدراسة؟

الغرض من هذه الدراسة هو استكشاف العوائق والميسرات عند استخدام التدخل الصحي الرقمي كنهج للإدارة الذاتية بين أخصائي العلاج الطبيعي ومرضى العظام والمفاصل في المملكة العربية السعودية. في المرحلة الثانية، سوف تستكشف هذه المقابلة مجالات الاهتمام التي تم تحديدها في الاستطلاع عبر الإنترنت.

2- ما هو تدخل الصحة الرقمية؟

التدخل الصحي الرقمي هو إيصال المعلومات الصحية عبر منصة رقمية، مثل الهاتف المحمول أو موقع الويب. يمكن لأخصائي العلاج الطبيعي مراقبة ومتابعة المرضى الذين يعانون من مشاكل في العضلات والعظام وكيفية إدارة حالتهم بأنفسهم عن بعد.

3- لماذا تمت دعوتي للمشاركة في هذه الدراسة البحثية؟

تمت دعوتك للمشاركة في هذه الدراسة لأنك تبلغ من العمر 18 عامًا أو أكثر ولأنك مريض يعاني من أي نوع من أمراض الجهاز العضلي الهيكلي وقد استخدمت التدخل الصحي الرقمي بدعم من أخصائي العلاج الطبيعي لمدة شهرين على الأقل.

4- هل مشاركتي إجبارية؟

لا، مشاركتك في هذا المشروع البحثي تطوعية تمامًا، والأمر متروك لك لتقرير ما إذا كنت ستشارك أم لا. إذا اخترت القيام بذلك، سيُطلب منك التوقيع على نموذج موافقة. إذا قررت عدم المشاركة، فلا يتعين عليك توضيح السبب (أو الأسباب) الخاصة بك، ولن يؤثر ذلك على حقوقك القانونية. لك مطلق الحرية في سحب موافقتك على المشاركة في مشروع البحث في أي وقت دون إبداء سبب، حتى بعد التوقيع على استمارة الموافقة. أيضًا، لن يكون هناك أي تأثير على رعايتك السريرية، سواء قررت المشاركة في الدراسة الحالية أم لا.

5- ماذا ستشمل المشاركة؟

إذا قررت المشاركة، يمكنك قراءة هذه الورقة لمدة ثلاثة أيام وبعد ذلك يمكنك إرسال رسالة تأكيد بالبريد الإلكتروني إلى الباحث. ستحتاج إلى التوقيع على نموذج موافقة وبعد ذلك ستشارك في مقابلة عبر الإنترنت تُجرى عبر Zoom. من المتوقع أن تجرى هذه المقابلة بين شهر يونيو ٢٠٢١ وشهر يوليو ٢٠٢١. ستكون المقابلة مسجلة بالصوت، و سيتم الاحتفاظ بالتسجيل لأغراض البحث. ستستغرق المقابلة حوالي 45 دقيقة وستتناول خبراتك وأفكارك حول استخدام التدخل الصحي الرقمي في ممارستك. لأغراض الخصوصية، سيتم إرسال رابط غرفه الاجتماعات Zoom عبر البريد الإلكتروني، وسيتم توفير كلمة مرور لرقم التعريف. لن يتمكن أحد سواك أنت والباحث من الوصول إلى غرفة الاجتماعات هذه.

6- هل سأدفع مقابل المشاركة؟

لا، لن يتم الدفع لك مقابل المشاركة في الدراسة الحالية.

7- ما هي الفوائد المحتملة للمشاركة في هذه الدراسة؟

لن تكون هناك مزايا أو فوائد مباشرة للمشاركة في هذه الدراسة. ستساعدنا مساهمتك على فهم العوائق أو العوامل الأخرى في التدخل الصحي الرقمي. سيساعد هذا في تحسين استخدام التدخل الصحي الرقمي في الإدارة الذاتية لأمراض الجهاز العضلي الهيكلي من خلال الإبلاغ عن وضع توصيات جديدة للمملكة العربية السعودية.

8- ما هي المخاطر المحتملة للمشاركة في هذه الدراسة؟

ليس هناك مخاطر محدودة مرتبطة بالمشاركة في هذه الدراسة. ومع ذلك، قد تشعر بالقلق أثناء أو بعد الانتهاء من المقابلة. سيدعمك الباحث ويحيلك إلى أخصائي العلاج الطبيعي للحصول على الدعم الذي تحتاجه. قد يحدث إجهاد العين بسبب استخدام جهاز كمبيوتر أو جهاز رقمي آخر، ولكن يمكن التحكم في ذلك عن طريق أخذ قسط من الراحة. تعتبر رفاهية المشاركين ضرورية خلال هذه الفترة الوبائية؛ لذلك، يمكنك إخبار الباحث أن يدعمك إذا شعرت بعدم الراحة أو عدم الارتياح. يمكن للباحث إيقاف المقابلة إذا أردت، ويمكن إعادة تحديد موعد آخر.

9- كيف سيتم الحفاظ على سرية مشاركتي؟

سيتم التعامل مع جميع المعلومات التي تم جمعها منك خلال المشروع البحثي بسرية تامة وسيتم تخصيص رمز مرجعي لجميع المشاركين في هذه المرحلة من الدراسة. من خلال القيام بذلك، لا يمكن ربط المعلومات التي تقدمها بأي فرد. سيتم الاحتفاظ بجميع البيانات في مجلدات محمية بكلمة مرور ولن يتم الوصول إليها إلا من قبل الباحثة ومشرفيها. ومع ذلك، إذا حدد الباحث أي معلومات قد تسبب قلقاً على سلامتك أو رفاهيتك، فقد يتم تجاوز سرية بياناتك، ويتم الكشف عن المعلومات للسلطة المسؤولة مثل أخصائي العلاج الطبيعي المسؤول. ستتم إدارة أي معلومات شخصية تقدمها وفقاً للتشريع العام لحماية البيانات (GDPR).

10- ماذا سيحدث لبياناتي الشخصية؟

ستتم معالجة جميع المعلومات وفقاً لإرشادات اللائحة العامة لحماية البيانات. وهذا يعني أن أي معلومات تتعلق بالبيانات الشخصية (الاسم، والعمر، والجنس، والبريد الإلكتروني)، ستتم حمايتها بموجب قانون حماية البيانات وقانون حماية البيانات في جامعة كارديف. قد يتم استخدام البيانات التي سيتم جمعها لأغراض علمية مثل النشر أو ناتج باحث آخر. سيضمن الباحث عدم نشر أي معلومات من شأنها أن تسمح بتحديد هوية الأفراد. سيتم حذف جميع البيانات الشخصية في نهاية الدراسة. لمزيد من المعلومات حول حماية البيانات، تشمل:

-حقوقك

- الأساس القانوني الذي بموجبه تقوم جامعة كارديف بمعالجة بياناتك الشخصية للبحث
- سياسة حماية البيانات بجامعة كارديف
- كيفية الاتصال بمسؤول حماية البيانات بجامعة كارديف
- كيفية الاتصال بمفوض المعلومات

يمكن العثور عليها <https://www.cardiff.ac.uk/public-information/policies-and-procedures/data-protection>

11- ماذا سيحدث للبيانات في نهاية المشروع البحثي؟

سيتم نسخ المقابلة وإرسال نسخة إليك بالبريد الإلكتروني. سيكون لديك أسبوع واحد للقراءة وإخطار الباحث إذا كان هناك أي تغييرات يجب إجراؤها. سيتم تحليل المعلومات التي تقدمها وتقديمها في أطروحة ومشاركتها عبر أي منشور أو عرض تقديمي حول البحث. سيتم إخفاء هوية جميع الاقتباسات والبيانات عن طريق استخدام أسماء مستعارة. سيتمكن المشرفون والباحث فقط من الوصول إلى البيانات الأولية. سيتم الاحتفاظ ببيانات الدراسة على خوادم محمية بجامعة كارديف وسيتم الاحتفاظ بها لمدة 5 سنوات من إكمال هذا المشروع؛ بعد ذلك، سيتم حذفه.

12- ماذا لو حدث خطأ ما؟

تم اتخاذ الخطوات اللازمة لمنع أي مشاكل متوقعة. ومع ذلك، إذا كانت لديك أي شكاوى أو مخاوف بشأن هذا البحث، فيرجى الاتصال بي، روى سروجي (طالبه دكتوراه) على [REDACTED] يمكنك أيضًا الاتصال بمشرفي الأبحاث [REDACTED] على [REDACTED] أو [REDACTED] على [REDACTED] من كلية علوم الرعاية الصحية بجامعة كارديف.

إذا شعرت أنه لم يتم التعامل مع شكاواك على نحو يرضيك، فيمكنك أيضًا الاتصال [REDACTED] مدير إدارة البحوث، كلية علوم الرعاية الصحية، على [REDACTED] أو على [REDACTED]

13- من يقوم بهذه الدراسة؟

سيتم إجراء البحث من قبل روى سروجي (طالبه دكتوراه) وسوف يتم الإشراف عليها من قبل [REDACTED] من كلية علوم الرعاية الصحية بجامعة كارديف.

14- من قام بمراجعة الدراسة؟

تم منح هذا المشروع البحثي الموافقة الأخلاقية من قبل لجنة أخلاقيات البحث في كلية علوم الرعاية الصحية، جامعة كارديف، وسيتم اخذ الموافقة الأخلاقية من قبل وزاره الصحة لمنطقة الطائف ومكة في المملكة العربية السعودية.

15- بمن اتصل لمزيد من المعلومات؟

إذا كان لديك أي سؤال يتعلق بالدراسة، من فضلك لا تتردد في الاتصال بي روى سروجي (طالبه دكتوراه) عبر البريد الإلكتروني على: [REDACTED]

شكرًا لك على التفكير في المشاركة في هذا المشروع البحثي. إذا قررت المشاركة، فسيتم إعطاؤك نسخة من صحيفة معلومات المشارك هذه واستمارة موافقة موقعة للاحتفاظ بها في سجلك.

Appendix XVI: Arabic consent form (survey)



نموذج الموافقة (استبيان)

العوائق والميسرات عند استخدام التدخل الصحي الرقمي كنهج للإدارة الذاتية من قبل أخصائي العلاج الطبيعي والمرضى الذين يعانون من أمراض العضلات والعظام في المملكة العربية السعودية

الرجاء وضع الأحرف الأولى من اسمك ولقبك في كل مربع

- ☐ 1- أؤكد أنني قد قرأت ورقة المعلومات المؤرخة ٢٠٢١ / ٠٣ / ٢ للدراسة أعلاه وأتاحت لي الفرصة للنظر في المعلومات وطرح الأسئلة وحصلت على الإجابات بشكل مرض.
- ☐ 2- أفهم أن مشاركتي طوعية وأني حر في الانسحاب من الدراسة في أي وقت دون إبداء أي سبب وبدون تحيز.
- ☐ 3- أفهم أن جميع البيانات التي أقدمها ستعامل بسرية وأن جميع البيانات الشخصية ستكون مجهولة المصدر.
- ☐ 4- أوافق على أن أي معلومات أقدمها يمكن استخدامها في أي كتابة أو نشر أو عرض تقديمي حول الدراسة البحثية.
- ☐ 5- يمكنني تقديم بريدي الإلكتروني أو رقم الهاتف لتلقي دعوة للمراحل التالية.
-
- ☐ 6- أوافق على المشاركة في هذه الدراسة وأفهم أنني سأتلقي نسخة واحدة من هذه الموافقة الموقعة.

اسم المشترك	اليوم	التوقيع
اسم المشترك	اليوم	التوقيع

نسخه للمشارك: ونسخه يتم الاحتفاظ بها من قبل الباحث

Appendix XVII: Arabic consent form (interview)



نموذج الموافقة (للمقابلة)

العوائق والميسرات عند استخدام التدخل الصحي الرقمي كنهج للإدارة الذاتية من قبل أخصائي العلاج الطبيعي والمرضى الذين يعانون من أمراض العضلات والعظام في المملكة العربية السعودية

الرجاء وضع الحرف الأول من اسمك ومن لقبك في كل مربع

☐

1- أؤكد أنني قد قرأت ورقة المعلومات المؤرخة ٢١/٠٣/٠٢ للدراسة أعلاه وأتاحت لي الفرصة للنظر في المعلومات وطرح الأسئلة وحصلت على الإجابات بشكل مرض.

☐

2- أفهم أن مشاركتي طوعية وأني حر في الانسحاب من الدراسة في أي وقت دون إبداء أي سبب وبدون تحيز.

☐

3- أفهم أن جميع البيانات التي أقدمها ستعامل بسرية وأن جميع البيانات الشخصية ستكون مجهولة المصدر.

☐

4- أوافق على التسجيل الصوتي لمشاركتي في المقابلة.

☐

5- أوافق على أن أي معلومات أقدمها يمكن استخدامها في أي كتابة أو نشر أو عرض تقديمي حول الدراسة البحثية.

☐

6- أوافق على المشاركة في هذه الدراسة وأفهم أنني سأتلقي نسخة واحدة من هذه الموافقة الموقعة.

اسم المشترك/ة	اليوم	التوقيع
اسم الباحثة	اليوم	التوقيع

نسخه للمشارك: ونسخه يتم الاحتفاظ بها من قبل الباحث

Appendix XVIII: Interview schedule (physiotherapist)

1-Physiotherapy interview schedule:

Thank you for agreeing to take part in this study. I am fascinated to know more about your opinion about using digital health interventions with your patients and the barriers and the motivations. If you are not sure about any of the questions, please let me know, and I will rephrase accordingly. Also, do let me know if there were anything you would like to share that we have not discussed at the end of the interview. Do you have any questions before we start? If you are happy with everything. I will start the recording...

Introductory questions

Tell me about your experiences of using DHIs?

- What did you use?
- What is your reason for using DHIs?
- Did that motivate you? If yes, why did that motivate you? If no, what would motivate you?

What do you hope to achieve by recommending DHIs?

- Did you achieve your goal?

Were there any problems facing you when using DHIs?

- If yes, what were the problems?
- How did you go about solving them?
- Was there any support if you faced any difficulties with the DHI?

Did you receive any support from your organisation/colleague while using the DHI?

- If yes, can you tell me more about how they supported you?
- If no, is there any reason why did they not support you?

How well-equipped are you to use DHI?

Were you taught/trained to use the DHI?

- Do you feel there is a need for training for physiotherapists to use DHIs?

How does the DHI fit in your practice?

- How do you benefit from using DHI?
- How did the DHI impact your productivity?
- How did the DHI affect your time management or workload management?
- How did the DHI affect the effectiveness of your prescribing the therapy

How regularly do you use DHI?

Have you notice any cultural barrier when using DHI?

- If yes, what is it?
- If no, how does the DHI align with the Saudi/Islamic customs?

How do you decide which patients to recommend DHI?

- How do you decide which patients to Not recommend DHI?
- How did the DHI impact your patients' self-management?

When using DHI, how do you monitor the patient's progress?

How did DHI impact your patients' knowledge about the condition?

How regularly do your patients use the DHI?

What do you think will motivate patients to use DHI?

Tell me about your relationship with your patients while using DHI?

- How you support your patient when using DHI?
- It is enough? Or they need something different/more?
- Do you feel that there is a need for training for patients to use DHIs?

How well does the DHI meet your patient's needs?

- Why does it meet/ not meet their needs?
- What are the patient needs?

Which do you prefer, face to face therapy or prescribing your DHI? Why?

What do you think would be the best way to encourage physiotherapists to utilise DHI?

Are there any issues/barriers you experienced that we have not talked about?

End question: Is there anything we did not cover that you would like to discuss?

Appendix XIX: Interview schedule (patient)

2-Patient interview schedule:

Thank you for agreeing to take part in this study. I am fascinated to know more about your opinion with using digital health intervention with your physiotherapists and the barriers and the motivations. Feel free to share anything from your perspective. If you are not sure about any of the questions, please let me know, and I will rephrase accordingly. Also, do let me know if there were anything you would like to share that we have not discussed at the end of the interview. Do you have any questions?

If you are happy with everything, I will start the recording...

Introductory questions

Tell me what was /is the condition that you are using a DHI for?

Tell me about your experiences of using DHIs for your knee (or whatever it is condition)?

- What DHIs did you use?
- How regularly do you use the DHI?
- Why did you use DHIs?
 - What would motivate you to keep using DHI?
- Did you find DHI easy or difficult? Why?
 - (a) How well-equipped are you to use DHI?
 - (b) Were you taught/trained to use the DHI?
 - (c) Did you feel you needed training to use DHIs?
 - (d) Was there any support if you faced any difficulties with the DHI?
 - (e) What did you think about the instructions on the DHI?

How did the DHI impact your ability to help yourself with your condition?

How well does the DHI meet your needs for your problem (with your knee or based on the patient's condition)?

- Why does it meet your needs?
- What needs does it meet?
- What needs does not it meet?
- Do you find it useful?
 - If yes, What for?
 - If no, why not?

When using the DHI, how do you monitor your progress?

- What do you hope to achieve by using DHIs?
- Did you achieve your goal?

How did the DHI impact your knowledge about your condition?

Have you notice any cultural barrier when using DHI?

- If yes, what is it?
- If no, how does the DHI align with the Saudi/Islamic customs?
- How does the DHI fit in your daily life?

Did you receive any support from your family or friends while using DHI?

- If yes, can you tell me more about how they supported you?
- If no, is there any reason why did they not support you?

Tell me about your relationship with your physiotherapists while using DHI?

- How does the physiotherapist support you when using DHI?
- It is enough? Or you need something different?

Which do you prefer, face to face therapy or using your DHI? Why?

Are there any issues/barriers you experienced that we have not talked about?

What do you think would be the best way to encourage people to utilise DHI?

End question: Is there anything we did not cover that you would like to discuss?