Internet Re

From Resistance to Acceptance: Developing Health Task Measures to Boost mHealth Adoption among Older Adults: Mixed-Methods Approach and Innovation Resistance

Journal:	*Internet Research*
Manuscript ID	INTR-02-2024-0327.R1
Manuscript Type:	Research Paper
Keywords:	Mobile Health Applications, Innovation Resistance Theory, Health Task Management Support, Mixed-Methods, Ageing Population, Technology Adoption, Barriers, Older Adults, Qualitative Study, Quantitative Study, Healthcare Technology

From Resistance to Acceptance: Developing Health Task Measures to Boost mHealth Adoption among Older Adults: Mixed-Methods Approach and Innovation Resistance

Abstract

Purpose – There are two main objectives in this study. First, we aim to develop a set of constructs, namely health task management support (HTMS) features, to evaluate what health-related tasks are supported by the functions of mobile health applications (mHealth apps). Second, drawing on innovation resistance theory (IRT), we examine the impacts of the newly developed HTMS dimensions on perceived usefulness, alongside other barrier factors that contribute to technology anxiety. We also explore how both perceived usefulness and technology anxiety affect the adoption of mHealth apps among older adults.

Design/ methodology/ approach – Using a mixed-method research design, this research seeks to develop new measurement scales that reflect how mHealth apps support older adults' health-related needs based on interviews. Then, we collected data from older adults and adopted exploratory factor analysis (EFA) to understand the structure, validity and reliability of the newly developed measurement scales. Subsequently, Partial Least Square-Structural Equational Modelling (PLS-SEM) was adopted to analyse survey data from 602 older adults, to explore the distinct effects of HTMS and technology anxiety on older adults' intention to adopt mHealth apps.

Findings – Three dimensions, namely, medical management task support, healthy diet task support and exercise task support, were extracted from exploratory factor analysis. The PLS-SEM results revealed that medical management task support, healthy diet task support and exercise task support were positively associated with perceived usefulness, whilst perceived complexity and dispositional resistance to change were found as antecedents of technology anxiety. Subsequently, perceived usefulness and technology anxiety were found to be a positive and negative driver of adoption intention, respectively.

Research limitations/implications – This study has adopted a qualitative method to develop a new measure to evaluate the support provided by mHealth apps for health-related tasks among older adults, offering a comprehensive and relevant measurement to healthcare and IS literature. Future studies may adopt this new construct to measure how other healthcare systems support older adults with common health-related tasks and to explore how mHealth apps improve older adults' health management performance and well-being.

Originality/ value – Although mHealth apps are considered useful technologies in improving older adults' wellness, understandings of how mHealth apps help older adults accomplish their health-related tasks are yet to be explored. This study contributes to the IS literature by developing a multidimensional construct, namely HTMS, that reflects how older adults' health-related needs can be supported by features of mHealth apps. Drawing on IRT, we complement the extant literature on resistance to innovation by systematically examining the impact of five types of barriers on technology anxiety, along with exploring how the three dimensions of HTMS drive perceived usefulness and mHealth app adoption.

Keywords: Mobile Health Applications, Innovation Resistance Theory, Health Task Management Support, Mixed-Methods, Ageing Population, Technology Adoption, Barriers, Older Adults, Qualitative Study, Quantitative Study, Healthcare Technology

1. Introduction

With the advances in medicine, humans are living longer than ever before. This phenomenon is a positive sign for global well-being. However, here comes the challenge of moving from ageing to successful longevity. When ageing occurs, the elderly start to suffer from poorer health conditions that threaten their autonomy and quality of life, putting a huge burden on the public healthcare system. Facing the trend of population ageing, policymakers and solution providers worldwide have invested considerable technological resources to help the elderly maintain healthy and productive lives (Jakovljevic *et al.*, 2021). Digital transformation of healthcare services, particularly through the use of mobile technology, is a key strategy for addressing these challenges. Given the widespread use of mobile devices, mobile health applications (mHealth apps) have been developed to help older adults manage their health-related tasks (Faverio, 2022). There were more than 325,000 mHealth apps on mobile app platforms, including Apple App Store and Google Play Store (Grundy, 2022). mHealth apps provide substantial benefits to older adults by supporting their daily health-related tasks such as medication reminders, medical appointments, diet management, and so on (Morey *et al.*, 2019). While there are plenty of mHealth apps available for free download from different application platforms, their acceptance and adoption among the elderly remain low (Franklin and Myneni, 2018). For instance, only 25% of older adults have had digital health technology usage experience in the U.S. (Levine *et al.*, 2016). In particular, a recent report shows that 28% of 2,110 interviewees aged between 50 and 80 have used at least one mHealth app, while 16% have dropped out of the use finally (Lee *et al.*, 2022). Another report showed that 43% of the elderly quit using the apps in the first 14 days of their adoption (Wang *et al.*, 2022). These statistics indicate that a large number of older adults still have not embraced the use of mHealth apps, which raises a research question for scholars and practitioners: why are older adults not adopting them?

Many studies have attempted to explain individuals' willingness to adopt mHealth apps through the lens of positive research frameworks such as technology acceptance model (TAM) (Birkmeyer *et al.*, 2021; Palos-Sanchez *et al.*, 2021; Sezgin *et al.*, 2017), unified theory of acceptance and use of technology (UTAUT) (Garavand *et al.*, 2019), diffusion of innovation theory (Lin and Bautista, 2017), positive IT characterises (Esmaeilzadeh, 2021), attachment theory (Li *et al.*, 2020), and social support theory (Suh and Li, 2022). Nevertheless, according to innovation resistance theory (IRT), the market failure of innovations is largely due to consumer resistance, in which studying the factors of resistance is more essential to tackling the barriers to innovation and providing insights into technology adoption (Laukkanen *et al.*, 2007; Molesworth and Suortti, 2002; Ram, 1987; Ram and Sheth, 1989). Hence, understanding individuals' resistance to using mHealth apps is critical for app developers to better prioritise their investment and effort (Franklin and Myneni, 2018). Even though some studies have employed both positive and negative factors to predict older adults' intention to use mHealth apps, for instance, the TAM factors and feelings of anxiety about medical apps (Askari *et al.*, 2020), trust and risk beliefs (Fox and Connolly, 2018; Klaver *et al.*, 2021), as well as the unified theory of acceptance and use of technology (UTAUT) and technology anxiety (Hoque and Sorwar, 2017), these studies have failed to 1) identify which barriers to using mHealth apps apply to older adults from a theoretical perspective (Engelsma *et al.*, 2021; Trinh *et al.*, 2023), and 2) evaluate what health-related tasks are indeed supported by the functions of mHealth apps because the widely tested factor – perceived usefulness – is too abstract for assessing the effectiveness of mHealth apps (McFarland and Hamilton, 2006; Shih, 2004). In this regard, this study employs a mixed-methods approach to first develop other aspects to evaluate the usefulness of mHealth apps, and then adopts IRT to examine the impact of a set of barriers on mHealth app adoption through technology anxiety.

First, one of the key factors affecting technology adoption is technology anxiety in the discipline of information systems (IS), which is a negative affective response to technology use, and it is negatively linked to the willingness to adopt new technology (Meng *et al.*, 2022). In particular, the elderly tend to have higher levels of computer anxiety compared to young adults, often due to a decline in their physical and cognitive conditions (Laguna and Babcock, 1997). However, prior studies have only examined the impact of technology anxiety on the intention to use mobile healthcare technologies (Lin *et al.*, 2020; Talukder *et al.*, 2021), overlooking the antecedents that predict technology anxiety. IRT posits that resistance to innovation adoption comes from five general barriers, classified into functional and psychological aspects (Ram and Sheth, 1989). Drawing on IRT, this study aims to identify which barriers are most important to technology anxiety about mHealth apps. Second, although perceived usefulness is generally used to evaluate the overall effectiveness of using mHealth apps, it is challenging to reflect the specific health tasks that mHealth apps can support solely through the lens of perceived usefulness. Investigating what functions of mHealth apps are considered important by older adults for handling their health-related tasks is therefore critical to understanding their adoption. Some studies reported that the elderly may feel there is a mismatch between their health needs and the functions of the mHealth apps on offer (Tong *et al.*, 2022; Vergouw *et al.*, 2020). However, the existing literature lacks a comprehensive measurement to assess the extent to which the functionality of mHealth apps supports the needs of users in healthcare-related activities. In addition, the literature has discussed common health problems faced by the elderly, for instance, forgetting medications (Gomes *et al.*, 2020), frequent visits to medical institutions for various diseases (Osborn et al., 2014), lack of regular physical activity (Rosa *et al.*, 2022), and the problem of constipation based on Rome II criteria (Dreher, 2018; Okuyan and Bilgili, 2019), there are scarce research systematically measuring which health-related tasks older adults usually do, let alone developed measurement scales that can support them in managing these health-related tasks through mHealth apps. Due to a lack of comprehensive and accurate measurement items, it is difficult for scholars to assess the actual benefits of using mHealth apps. Hence, by developing a new measure to assess which health-related tasks the elderly usually do, we can understand how well mHealth apps support users in performing the tasks as well as better explains the overall effectiveness of using mHealth apps.

Many recent studies have already suggested using mixed-method research, as it is a natural complement to the conventional quantitative and qualitative approaches (Venkatesh *et al.*, 2013). Hence, drawing on IRT and TAM, we 1) first conduct a qualitative study to develop a new scale to measure the functions of mHealth apps that manage health-related tasks commonly performed by older adults, and then 2) investigate the impacts of facilitators and barriers on older adults' adoption intention. Employing both qualitative and quantitative methods can help scholars to understand and explain their research problems deeply and broadly. Especially, in a qualitative study, scholars can enhance their understanding of a phenomenon they are trying to measure and ensure the validity of a new scale. Furthermore, applying the newly developed scale in the subsequent quantitative study can provide empirical support to predict or explain the outcomes, enhancing the generalizability of the findings (Shi *et al.*, 2022; Venkatesh *et al.*, 2013). Through employing mixed methods, a qualitative method is employed to develop a new measure to evaluate how mHealth apps support users in managing their common health-related tasks and their impacts on perceived usefulness. On the other hand, a quantitative approach is used to examine how drivers and barriers differently affect older adults' intention to use mHealth apps based on IRT and the new measure, offering fresh insights to healthcare application developers, older adults, governments, and caregivers.

Employing a mixed-method empirical design, this study is expected to contribute to theory and practice in three distinct ways. First, we employed a qualitative method to develop a new measure to evaluate the support provided by mHealth apps for health-related tasks among older adults, offering a comprehensive and relevant measurement to healthcare and IS literature. Future studies may adopt this new construct to measure how other healthcare systems support older adults with common health-related tasks, rather than solely using perceived usefulness. Second, drawing on IRT, we complement the extant literature on resistance to innovation by systematically examining the impact of five types of barriers on mHealth apps adoption, identifying which barrier most significantly affects older adults' intention to use mHealth apps through technology anxiety. Since, the scant understanding of why older adults experience anxiety in response to the use of mHealth apps in the literature, exploring the antecedents of this anxiety provides valuable insights. It enables scholars and app developers to better identify effective coping strategies for overcoming these barriers, thereby changing their attitudes and perceptions (Ram and Sheth, 1989). Third, since prior literature on mHealth app adoption among older adults is limited, a mixed-method design can improve the content validity of the scale by identifying items and dimensions of health-related tasks that may not be obvious through a quantitative method alone. A subsequent quantitative study enables scholars to test the reliability and validity of the newly developed constructs in larger samples (Venkatesh *et al.*, 2016a).

2. Theoretical background

2.1. Healthcare in the Digital Age: Progress, Challenges, and the Road Ahead

Digital transformation refers to "a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies" (Vial, 2019, p. 118). Human society has been in the midst of digital transformation in recent years. This shift is driven by several factors, for instance, the greater availability of digital data, the declining costs of technologies, and the growing demand for more convenient and personalized services. Hence, digital transformation is becoming more prevalent in different industries and is having profound impacts on our lives. For example, digital technologies are being used to improve the efficiency of business operations, to develop personalized goods and services, and to offer consumers with more convenient access to them. This creates new business opportunities, enables new business models, and transforms the interactions among individuals, companies, and governments (Greenstein *et al.*, 2013). As industries continue to evolve, digital technologies will play an important role in shaping the future of their businesses. Nevertheless, the radical and often unplanned changes triggered by an increasing diffusion of digital technologies also bring challenges to businesses. Digital transformation in an industry is a long and complex process. It covers everything from infrastructure to application integration and the provision of goods and services (Schneider and Kokshagina, 2021). The healthcare industry's inherent complexity has rendered its adoption of digital transformation more challenging and somewhat slower than that of other industries (Istepanian *et al.*, 2021).

As people live longer, there will be a demand for better elderly healthcare. Elderly health problems like dementia and Alzheimer's diseases need to be taken care of. Moreover, noncommunicable diseases like stroke and diabetes are common among the elderly, accounting for 70% of global deaths. This shows that there is a need to plan strategies for prevention, diagnosis, and optimized healthcare (World Health Organization, 2018). However, global spending in the healthcare sector surpassed $8.7 trillion in 2020 because of inefficient care delivery (Deloitte, 2018) and the increased budget in medicine development (i.e., $2.6 billion for each new drug launched) (DiMasi *et al.*, 2016). Given its reliance on complex processes and data, the healthcare industry is under increasing pressure to improve patient outcomes while controlling costs, and hence, is particularly well-suited to digital transformation. Nowadays, the escalating cost of elderly healthcare is a concern to all governments globally, while the advancement in digital healthcare is striving to provide better healthcare services for all humans. Digital healthcare empowers patients with consumerization. It makes patients more actively participate in treatment decisions, value-added services, home diagnosis, information sharing, etc. (Gomez-Gonzalez and Reyes, 2017). Digital transformation in health services is considered a significant and impactful process. It has already influenced existing healthcare systems and infrastructure and is expected to bring further changes to healthcare service delivery in the future (Ricciardi *et al.*, 2019). For instance, the future healthcare system will be more consumer-centric due to the influence of digital transformation, while the public may have more responsibility to get involved in the process (Ricciardi *et al.*, 2019).

Mobile health service is one of the examples of digital healthcare that is impacting the world. As technology advances, more diagnostic data can be collected and analyzed from connected medical devices. Such electronic medical records from wearable devices and mobile phones also contribute such large amounts of data. In addition to the popularity of mobile devices, there were more than 325,000 mHealth apps available in 2017 (Pohl, 2017). Smartphones now store numerous data, including health-related data. They can be considered mini-medical devices that are capable of monitoring and analyzing the health status of users.

Some healthcare services can be transformed to virtual form and semi-autonomous mode (Topol, 2015). In the context of mHealth, digital transformation concerns transforming healthcare service to a digital form, such as digital medical records and appointments, telemedicine services, etc. (Ricciardi *et al.*, 2019). Digitalization in healthcare can be both specific to the healthcare field and influenced by broader societal trends. These changes can bring healthcare technology innovations and transform health service delivery processes, ultimately affecting health systems. In certain aspects, digital transformation represents a fundamental shift in how institutions provide care (Ricciardi *et al.*, 2019).

Governments around the world have been implementing digital health programs in society to help citizens manage their health (Ricciardi *et al.*, 2019). In Hong Kong, the Electronic Health Record Sharing System (eHRSS) has been developed by the Hospital Authority to facilitate the flow of patients' medical records between public and private hospitals (Huang *et al.*, 2022). The system keeps track of each patient's medical record, such as demographics, prescription history, and clinical information, which allows hospitals and clinics to provide more accurate drug prescriptions and holistic treatment. The system was launched in 2016, and as of May 2022, more than 5.5 million citizens and 50,000 clinics have enrolled in this system, which is more than 72% of the population in Hong Kong (Huang *et al.*, 2022). Digital health services potentially empower patients and provide valuable attributes to the healthcare system. It is important to develop new digital healthcare technologies to provide higher quality and more responsive healthcare to citizens.

Despite the various benefits brought by the digital transformation of healthcare services, there are also some challenges in implementing it in society. For example, many mHealth apps are not well-tested, have poor quality, and lack proper regulatory authorization. Because of these technical challenges, mHealth has yet to be largely accepted by the public (Gopal *et al.*, 2019). Other than technical challenges, there are some social challenges for the elderly when they are encouraged to use mHealth services. Although digital health service can indeed provide some benefits to the public, it may also widen the gap in health achievement between different groups of people in society. As technical and literacy levels of people may vary across different sociodemographic groups, the adoption of digital health services like mHealth may negatively impact the equality between various society groups (Ricciardi *et al.*, 2019). This issue is referred to as the "digital divide," in which some groups of people may encounter more barriers when exposed to technologies (i.e., online accessibility, affordability, and lack of digital literacy) compared with other groups of people. Certain sociodemographic groups are at a disadvantage in adopting mHealth, for example, low-education groups and the elderly. They have fewer opportunities or insufficient knowledge to use this technology. Research showed that the higher socioeconomic status group (i.e., high education and high-income groups) usually adopts and benefits from new technologies earlier than the low socioeconomic status groups (i.e., the elderly and low-education groups) (Ricciardi *et al.*, 2019).

Digital transformation is expected to significantly enhance clinical outcomes (Stockman, 2006) and contribute to reducing healthcare costs (Hillestad *et al.*, 2005). It provides ample opportunities for the healthcare industry to radically alter service delivery (Agarwal *et al.*, 2010). However, the expected profound change has not yet fully taken place. The healthcare industry has been making gradual progress in digital transformation, but it moves at a rate slower than that of other sectors, and thus, is often seen as a laggard in embracing digital transformation (Kohli and Johnson, 2011). Companies and governments are searching for ways to support service providers by assessing the value of healthcare, focusing on enhancing public health, and minimizing costs. In the long run, the financial structure of healthcare will be the main force shaping innovative approaches within the sector (Gopal *et al.*, 2019). New digital health services are effective for users based on their acceptability and ease of use. It is also important to evaluate the experience of professionals with these technologies, as some systems might be complex and time-consuming to learn, which potentially increases the workload of the already overburdened healthcare providers. Additionally, the varying degrees of acceptance by both professionals and patients play a critical role in the successful implementation and consistent use of these technologies (Ricciardi *et al.*, 2019). Therefore, within the context of digital transformation, it is crucial to identify the barriers and incentives that affect the adoption of mHealth apps among low socioeconomic status groups, particularly older adults.

2.2. mHealth Apps and Older Adults' Health-related Tasks

With the wide usage of mobile devices, many governments, universities, and medical organisations deliver a wide range of healthcare services to individuals through smartphones in the form of mHealth apps. mHealth apps are defined as mobile applications that provide functions for users to improve their health (Wang *et al.*, 2021). mHealth apps provide users with various features, for instance, blood pressure assessment, calorie consumption calculation, remote diagnosing, weight management, pill reminder, stress management, coping with chronic conditions and so on (Vaghefi and Tulu, 2019). mHealth apps allow users to monitor their health and engage in health management actively (Hu et al., 2023). Older adults would benefit substantially from the use of mHealth apps in different aspects (Meng *et al.*, 2019). Typically, four main health tasks of older adults could be supported by mHealth apps, namely medication task, medical appointment task, exercise task, and dietary task. For medication task, mHealth apps can remind and notify users to take medication on time and with proper proportion. It can also provide non-prescription medication information (Park *et al.*, 2019; Pérez-Jover *et al.*, 2019). For medical appointment task, mHealth apps can link and track the appointments users made with the healthcare providers, and remind attain to attain the reserved medical appointment punctually (Liu *et al.*, 2018; Lv *et al.*, 2019; Park *et al.*, 2019). For exercise task, mHealth apps provide self-monitoring functions for users to record and review their physical activity. It will also remind them to stick with the exercise routines (MacPherson *et al.*, 2019; Oba *et al.*, 2023; Voth *et al.*, 2016). For dietary task, mHealth apps provide nutrition information of food and suggest healthy diets for users, some apps can even analyse the pictures of the users before and after eating and provide personalised suggestions (Dute *et al.*, 2016; Helander *et al.*, 2014; West *et al.*, 2017). Regardless of the benefits of mHealth apps for the elderly, the adoption of the apps is not ideal. Hence, this study aims to investigate the drivers and barriers to mHealth app adoption. Additionally, scholars have adopted the existing scales from TAM and UTAUT to explain the adoption of mHealth apps among older adults, including perceived usefulness (Palos-Sanchez *et al.*, 2021), perceived ease of use (Palos-Sanchez *et al.*, 2021), and performance expectancy (Camilleri, 2024). However, these measurement items were initially developed within the context of workplace efficiency and are used to measure the effectiveness of a system overall. While the TAM and UTAUT models are valuable, they tend to overlook which specific system functions contribute to effectiveness (McFarland and Hamilton, 2006; Shih, 2008). Hence, there is a need to understand what specific functions of mHealth apps the elderly emphasize in managing their health and how such functions contribute to the overall effectiveness of mHealth apps. In particular, the demographic characteristics of the elderly are distinctive due to their specific health needs, preferences, and obstacles when it comes to embracing technology. Due to their complex health conditions, which often include medication regimens (Kulkarni and Sathe, 2014), frequent healthcare appointments (Osborn *et al.*, 2014), the need for diet control (Wisten and Messner, 2005), and regular exercise (Taylor, 2021), their expectations and usage of mHealth apps significantly differ from young users. Therefore, their perceptions of the functions of mHealth apps in supporting their health-related tasks are likely to be multifaceted and valid measurement scales are needed to capture it. In light of this, our study developed a set of health task management support, which captures older adults' subjective evaluation of how well mHealth apps support their healthcare-related activities and how these apps meet their unique health management needs.

2.3 Applications of Innovation Resistance Theory in Technology Adoption

Sheth (1981) is the first scholar to propose a concept of innovation resistance, which offers a reversible thinking to explain why individuals resist adopting a particular innovation. Different from the idea of innovation diffusion which emphasises the positive way of spreading innovations through communication channels (Rogers *et al.*, 2014), innovation resistance focuses on the resistance-oriented behaviours of individuals resulting from rational thinking about an innovation that may change their existing status quo and deviate from existing belief systems (Hew *et al.*, 2019). The alterations in one's lifestyle and behaviour resulting from the adoption of new innovations may prompt individuals to develop resistance-oriented attitudes and behaviours (Ram and Sheth, 1989). Innovation resistance plays a significant role in leading the success or failure of innovations (Ram and Sheth, 1989). In the marketing literature, Ram and Sheth (1989) extended IRT by identifying major barriers and discussing the barriers that consumers face when making purchase decisions for new products or services. IRT helps marketers identify specific barriers and develop targeted marketing strategies to remove barriers, enabling innovations can be smoothly and easily accepted by consumers. In particular, Ram and Sheth (1989) suggest that innovation resistance can be categorised into active and passive resistances. Active resistance refers to the behaviour of resisting innovation derived from the characteristics of the innovation; it is covered by the functional barrier of the IRT. The value, risk, and usage barriers arise when there is a conflict between adoption and these functional aspects. Other than that, passive resistance refers to the contradiction between the adoption and the existing beliefs. Psychological barriers like image and tradition barriers can be used to study these conflicts (Kaur *et al.*, 2020; Ram and Sheth, 1989).

For functional barriers, there are usage, value, and risk barriers. A usage barrier refers to the degree of effort needed to learn and adapt to a new system. When a system is too complex, it may discourage users from adopting innovations (Kaur *et al.*, 2020). The impact of complexity on attitudes to technological innovations is more significant to the elderly. As the sensory perception of the elderly declines, when they perceive that the technology is complex, they are more anxious about adopting it (Xi *et al.*, 2022). Hence, this study suggests complexity as the barrier of usage, which is defined as the extent to which the mHealth app is perceived as hard to learn or use (Rogers *et al.*, 2014). Value barrier is defined as the price-performance value of the innovation compared to the existing alternatives that can be used as substitutes (Ram and Sheth, 1989). Value barrier will occur if technology innovations fail to offer corresponding advantages or benefits to users (Chen *et al.*, 2022). In IS literature, perceived usefulness is generally denoted as the value that technology offers to enhance user performance or add value to tasks (Chen and Fu, 2018; Xu *et al.*, 2015). Perceived usefulness is the extent to which an individual perceives that using a specific technology will increase his/her job performance (Davis, 1989). This study considers perceived usefulness as value barrier, which refers to users' perceptions of the value or benefit of using mHealth apps relative to other health management approaches. Besides, risk barrier refers to the risk of adopting new products compared to the existing alternatives. Consumers are concerned that the innovation may not have been examined fully, raising the possibility that it could malfunction or fail to perform properly (Ram and Sheth, 1989). In IS literature, security refers to the measures taken to guard against risks in a system, such as unauthorised access and hacking, with the aim of ensuring data confidentiality and integrity (Ashibani and Mahmoud, 2017). Security concerns about healthcare technology innovations are a significant barrier to adoption among patients as they worry that their personal information will be hacked or transmitted insecurely due to system failures (Sadeghi R. *et al.*, 2022). Understanding security concerns is important for overcoming adoption barriers when older adults are considering embracing new technology (Knight *et al.*, 2024). Hence, this study treats risk barrier as perceived security, which refers to the extent to which a mHealth app is secure for storing or transmitting personal health information. The adoption of new technologies is slow as users postpone the adoption until the risk and uncertainty are diminished (Kaur *et al.*, 2020). To resolve the functional barriers, product strategies are suggested to enhance the quality of innovations (Ram and Sheth, 1989). In the IS context, mHealth app developers should simplify the user interface of the system to offer a more user-friendly experience, incorporate robust features to satisfy user needs effectively, and enhance the security measures for storing and transmitting sensitive health information.

For psychological barriers, there are tradition barrier and image barrier. Tradition barrier occurs when the adoption of innovation changes consumers' routines and habits. When the routine or habit is important to the consumers, the more reluctant they are willing to use the innovation, and the higher the tradition barrier (Ram and Sheth, 1989). Tradition barrier refers to the unwillingness to change existing habits and daily routines (Mani and Chouk, 2018). The occurrence of this barrier is associated with the personal values and social norms of the potential users (Ram and Sheth, 1989). Users are reluctant to change their belief system when there is a conflict between the adoption and their beliefs (Laukkanen, 2016). According to cognitive load theory, as people age, the cognitive process will be slower. It poses challenges for older adults to learn innovations. This can be the reason that the elderly tend to stick with the existing routine (Sweller, 2011). Resistance to change refers to a generalised unwillingness to change caused by the perceived adverse consequences. In other words, dispositional resistance to change refers to the degree to which an individual's tendency to maintain existing behavioural patterns and reluctance to change the existing situation (Bhattacherjee and Hikmet, 2007). Individuals with higher dispositional resistance to change are less likely to change their usual routines and their minds, and more likely to be anxious while facing changes (Guo *et al.*, 2013). In this regard, tradition barrier is manifested by dispositional resistance to change. Besides, image barrier refers to the image brought by the innovation. The innovation might have different origins, product classes, brand names, etc. The image barrier occurs when the stereotypical thought of the product may cause negative or unfavourable image to consumers (Ram and Sheth, 1989). When the adoption is unfavourable to the personal image or the stereotype of the potential user, image barrier will occur and they are more unwilling to adopt the innovation (Ram and Sheth, 1989). In IS literature, compatibility refers to the extent to which a new technology matches with the image of potential users (Rogers *et al.*, 2014). Technology innovations that align with the personal image and social status of individuals, their adoption intention to a new technology is higher (Lin and Bautista, 2017). In view of this, image barrier can be represented by compatibility.

There are many studies applying IRT to study various innovation adoptions in different contexts. Kaur et al. (2020) made use of IRT to investigate the usage intention of mobile payment solutions. It was found that functional barriers, namely usage barrier, value barrier, and risk barrier, have significant negative correlations to use intention (Kaur *et al.*, 2020). On the other hand, Lian and Yen (2014) adopted IRT to investigate the impact of functional barriers and psychological barriers on intention to use online shopping. Their results showed that the usage intention of the elderly is significantly hindered by value barrier, risk barrier, and tradition barrier. However, for younger demographics, their usage intention is only affected by the value barrier (Lian and Yen, 2014). The results implied that older adults suffer from more innovation resistance than younger ones. Unlike mobile banking apps, which are primarily designed for transactional purposes, mHealth apps serve to monitor and manage health, requiring different levels of efforts in learning to use them and overcoming barriers to adoption. Particularly in this study, where older adults are the target respondents, this demographic often possesses lower technological literacy and may come from a lower socioeconomic status. Through the literature review, we observed that individuals encounter a variety of barriers to innovation in various contexts, which vary significantly across different age groups. In particular, the literature suggests that older adults are faced with a greater number of obstacles compared to younger adults (Lian and Yen, 2014). For instance, older adults may encounter physical challenges such as poor vision or hearing (Haanes *et al.*, 2019), which can hinder the way they interact with mHealth apps (Ghaffari *et al.*, 2016). Despite these aged-related problems, scholars contend that the primary barrier to technology adoption among this group is users' negative attitude. This resistance often stems from fear, anxiety, and a lack of motivation (Vroman *et al.*, 2015). Hence, there is a pressing need to investigate and understand the barriers that are creating anxiety as well as impeding the adoption of mHealth apps by older adults. Through applying IRT, we may provide a better explanation of the resistant-oriented behaviours of older adults, enriching our understanding of barriers to mHealth app adoption.

2.4. Technology Anxiety and Older Adults

Technology anxiety refers to a negative emotional reaction, like fear or worries, to the use of technology (Bozionelos, 2001; T. H. Tsai et al., 2020). The elderly have more salient technology anxiety than younger adults. One reason is that the declined physiological condition of the elderly may cause the functional decrease in sensory and motor systems (Laguna and Babcock, 1997). Besides, the elderly have less familiarity and computer literacy, which can result in negative emotion or attitude towards new technology, and thus resistance to the use of technology (Kim *et al.*, 2023; Or and Karsh, 2009). Hence, technology anxiety will be induced among the elderly more easily than youngsters. Most studies found that technology anxiety negatively impacts the perceived ease of use and perceived ubiquity of smart clothing (Tsai *et al.*, 2020), user intention to use healthcare systems such as a medical registry system (Özdemir-Güngör and Camgöz-Akdağ, 2018), eHealth records (Ruhi *et al.*, 2021), a wearable health device (Talukder *et al.*, 2021). Recently, Kim et al. (2023) conducted a systematic review on the effect of technology anxiety on older adults' technology adoption and then discussed the previous findings from the perspective of the digital divide. However, there is still limited research investigating the antecedents of technology anxiety towards mHealth apps for older adults. To address this gap, future research should investigate why and how it causes older adults' negative psychological responses to technology (i.e., technological anxiety) (Kim *et al.*, 2023). In response to this call, this study adopts IRT to identify determinants that contribute to technology anxiety, offering a deeper understanding of the reasons of anxiety and how to effectively alleviate these worries.

3. The mixed-methods design

Seeking to address both explanatory and confirmatory research questions and draw novel findings from practical perspectives and existing theories, A mixed-methods research design was adopted in this study, which comprises elements of both qualitative and quantitative approaches (Venkatesh *et al.*, 2016b). the strength of a [redacted] As the extant literature in the area of health-related task support in the context of mHealth apps is limited, [redacted] An interpretive approach using a qualitative study is conducted first (i.e., Study 1), and subsequently, based on the qualitative results, in Study 2, the positivist method is adopted to develop the research model for hypothesis testing.

4. Study 1: Conceptualising health-related tasks in mHealth apps

The objective of Study 1 is to explore how mHealth apps support elderly users in managing their health-related tasks. Following the procedures recommended in prior studies (e.g., Califf et al., 2020; Shi et al., 2022), a qualitative study was conducted to develop new measurement scales for constructs related to health-related tasks supported by mHealth apps.

4.1. Procedure of interviews

With the assistance of managers from two elderly service centres in Hong Kong, we carried out a series of in-depth, face-to-face interviews with older adults aged 60 years or above. To ensure the representativeness of the data, 21 older adults of different ages and genders were invited to participate in the interviews (Morse *et al.*, 2002), as the needs of older adults in their

60s may differ from those in their 80s. We have interviewed 16 female and 5 male older adults, ranging in age from 60 to 90 years old. [redacted]

The results of these interviews were used to identify the common health-related tasks that older adults do and the functions of mHealth apps they prefer using to support their management of health-related tasks. This enabled an in-depth understanding of how the elderly evaluate the usefulness of mHealth apps. The result of each interview was used to inform the subsequent interviews to ensure all health-related tasks supported by mHealth apps were identified. Code saturation was achieved after 21 interviews; even after adding new interviewees, the level of saturation remained unchanged, i.e., the categories of health-related tasks supported by the mHealth apps (Califf *et al.*, 2020). In particular, the initial 11 interviews resulted in approximately 70% of new codes and 65% of high-prevalence codes, with subsequent interviews contributing a few new codes each until saturation was reached. Finally, a range of common thematic issues were identified, and the codebook was stabilised through 21 interviews.

To ensure accurate transcription, one of the researchers reviewed a sample of seven interview transcriptions. In the initial stage, two researchers performed independent coding of the transcripts, which was followed by a comparison of their coding results and a discussion of emerging themes and categories. As a result, four common categories emerged. One researcher then coded the rest of the transcriptions according to the consensus categories and wrote an initial draft. The coding process was conducted again. The entire coding process involved seven iterations and two discussions to reconcile any discrepancies. After each iterative discussion of the themes and categories, all transcriptions were coded according to the consensus categories. Any potential disagreements among the coders were resolved through discussion until consensus had been reached (Javdan *et al.*, 2023).

4.2. Results of the qualitative study

According to the interview results, we have identified four main themes of health-related tasks. The first theme is medication task, where respondents emphasized various medication challenges they encounter. Most respondents expressed that they need to regularly replenish their medication, for example, visiting hospital monthly or quarterly. They also highlighted they have to adjust their doses according to their health situations, for instance, to change their blood pressure medication based on fluctuating readings. The prescription of the medication is complicated. Some have to take on empty stomach while some have to take after meals. It is a concern for the respondents. Respondents expressed that they need tools like a pill organizer to manage their pills taking schedule. They wish such tools can help them take medication on time daily and prevent missed doses because of their forgetfulness. Overall, medication task means that the elderly need to take their medication according to specific times, doses, and situations as well as go to hospitals or clinics to get medicine on a regular basis. Accordingly, older adults hope that mHealth apps can assist in regularly obtaining medicines from medical institutions, ensure compliance with prescribed dosages, provide guidance on taking medications on an empty stomach or after meals, and provide timely reminders to take medicines. In the second theme, medical appointment task, participants described that there are logistic challenges in scheduling and attending the medical appointments, especially for those who live in distant places from medical facilities or when requiring multiple specialists. The long interval between medical appointments and the possibility of forgetting them show the necessity for careful planning. Therefore, most respondents find it difficult to use their mobile phones to record schedule details to ensure they do not miss important follow-up support. To sum up, medical appointment task means that the elderly need to arrange their own medical appointments according to their needs. Therefore, older adults expect mHealth apps to schedule, record details of, and manage their medical appointments with various specialists.

The third theme focuses on exercise task, where the advice from healthcare professionals and the experiences of peers converges on the importance of regular physical activity. Participants mentioned a variety of recommended exercises, such as Tai Chi, walking, and swimming, each aimed at improving specific aspects of health like strength, balance, endurance, and alleviating pain. Thus, exercise task means that the elderly need regular exercise to stay healthy. Accordingly, older adults expect mHealth apps to remind them to initiate, maintain, and regularly engage in exercise routines. Lastly, the fourth theme, dietary task, reflects the participants' awareness of age-appropriate nutrition. Gathering the recommendation from medical experts, friends, and family, they are cautious about the food that may lead to health issues like diabetes, hyperlipidemia, and digestive problems. High-fiber diets and the avoidance of sugary, fried, and heavily processed foods were recommended to keep good health and prevent diseases. Hence, dietary task means that the elderly need to pay attention to their diet to maintain good health. Accordingly, older adults expect mHealth apps to help them avoid foods high in fat, salt, and sugar, ensure adequate fiber intake, steer clear of processed items like canned or pickled foods, and eschew indigestible foods. These themes together highlight the multifaceted nature of health task management support (HTMS) among older adults, encompassing medication, medical appointments, regular physical activities, and healthy diet. Each of these areas comes with its own specific challenges and needs.

Based on the themes identified in the interviews, 14 measurement items were developed across four dimensions of HTMS, namely, medication task support, medical appointment task support, exercise task support, and healthy diet task support. A pre-test was conducted with ten elderly subjects to make sure the relevance and comprehensibility of the measures. According to the feedback from these older adults as well as from five information systems professors, the measurement items were refined to ensure accuracy. Table 1 presents the definitions of these four dimensions, the related support derived from the interviews, and the practice of mHealth apps.

======================

Please insert Table 1.

======================

4.3. Exploratory factor analysis based on qualitative findings

As mentioned, 14 items across four dimensions of HTMS were established in the qualitative study. To confirm the validity of the newly established construct, exploratory factor analysis (EFA) was employed. EFA allows researchers to identify complex relationships between observed variables and latent variables, aiding in understanding the underlying dimensions of a new measurement scale (Hair *et al.*, 2010). A survey company was hired to recruit 500 older adults, aged 50 years or above for the EFA. After removing 21 invalid responses, 479 responses were used for EFA to examine the dimensionality of the HTMS scale. Principal components factor analysis with promax rotation, an oblique rotation, was used. We adopted Promax rotation because the extracted factors related to health task management are likely to be interrelated. The decision on the number of factors to extract was based on Eigenvalues and Scree plots.

To begin with, 14 HTMS items were subjected to factor analysis. The latent root criterion was used to retain factors with eigenvalues greater than 1.0, and the scree plot helped identify a three-factor structure. These extracted factors accounted for 75.2% of the total variance. Three items intended for the dimension of medical appointment task support and four items intended for the dimension of medication task support loaded onto one factor. Items for the dimension of medical appointment task support, aiming to measure how mHealth apps support appointment reminders and records, include "[This mHealth app] helps me to schedule my medical appointments", "[This mHealth app] helps me to record my medical appointments (e.g., date and location)", and "[This mHealth app] helps me to manage my appointments with different doctor specialists". The items for the dimension of medication task support, serving to measure how mHealth apps support medication intake and reminders, include "[This mHealth app] helps me to obtain medications from hospitals/clinics regularly", "[This mHealth app] helps me to take a certain dose of medication as instructed (e.g., 2 capsules each time)", "[This mHealth app] helps me to take medication according to different situations (e.g., empty stomach/after meals)", and "[This mHealth app] reminds me to take medications on time". One possible reason for all seven items loaded onto one factor is that the items of both dimensions are all concerning the scheduling and reminder functions of mHealth apps for managing health-related tasks. The factor loading of the item "[This mHealth app] helps me to manage my appointments with different doctor specialists" was lower than 0.70. Thus, this item was discarded, and the remaining 13 items were submitted to factor analysis again. In this round of factor analysis, as shown in Table 2, the factor solution extracted 76.5% of the total variance for the three-factor structure, with the factor loading of all items exceeding 0.70. According to the threshold of Hair et al. (2010), a factor loading of 0.70 or higher is considered significant. Given that the two items of medical appointment task support and the four items of medication task support loaded on one factor, a new label was given to this factor, namely medical management task support.

=====================

Please insert Table 2.

=====================

5. Study 2: empirical findings about antecedents of mHealth apps adoption intention

In Study 1, we conducted a literature review and qualitative interviews with older adults about their health-related tasks and their expectations of the benefits of using mHealth apps. Subsequently, this study aims to explore the importance of the three dimensions of HTMS in driving older adults' mHealth adoption. To obtain comprehensive findings, we examine how the three dimensions of HTMS drive perceived usefulness, along with the antecedents of technology anxiety, and how perceived usefulness and technology anxiety affect older adults' mHealth app adoption. Figure 1 depicts our research model in Study 2.

=====================

Please insert Figure 1.

=====================

6. Research model and hypothesis development

6.1 Relationship between medical management task support and perceived usefulness

According to our literature review in Table 1, older adults get more different diseases as they age. In particular, around 50% of the elderly have more than one chronic condition (Bergman-Evans, 2006). The elderly often get medical treatment from medical centres, they therefore developed a reliance on multiple medications (Cameron and Richardson, 2000). As the elderly generally have poor vision and memory, they can easily forget the time to take medicine and mix up the pills (Abdul Minaam and Abd-ELfattah, 2018). About 49% of the elderly frequently miss the medication schedule and take the wrong pills (Gomes et al., 2020). Taking medication is challenging for the elderly, especially when they lack the support of family and friends. Older adults encounter difficulties with medical appointments such as scheduling, and arranging transportation (Horton and Johnson, 2010). Hence, we argue that when mHealth apps enable the elderly to make medical appointments, remind them of medication schedules, etc, they can accomplish their health tasks on time and accurately, thereby increasing their perceived usefulness of mHealth apps. Thus, we propose the following hypothesis:

H1: Medical management task support is positively related to the perceived usefulness of mHealth apps.

6.2 Relationship between dietary task support and perceived usefulness

To manage chronic illnesses like hypertension and diabetes mellitus of the elderly, doctors suggest the elderly should avoid consuming food with high sugar (Chiaranai *et al.*, 2018), salt, and fat (Ree *et al.*, 2008). Rome II constipation diagnosis criteria pointed out more than half of the elderly suffer from constipation problems (Okuyan and Bilgili, 2019). Nevertheless, proper intake of dietary fibre is beneficial to alleviate and prevent constipation (Dreher, 2018). Therefore, the elderly are recommended to have a diet with high fibre intake such as vegetables and fruits (Wisten and Messner, 2005; Yang *et al.*, 2016). We, thereby, argue that when mHealth apps assist older adults to avoid unhealthy food and pay more attention to food nutrition, they will perceive the usage of mHealth apps as a convenient way to manage their weight or eating habits, thereby their usefulness perception of mHealth apps will be enhanced. Accordingly, we suggest the following hypothesis:

H2: Dietary task support is positively related to the perceived usefulness of mHealth apps.

6.3 Relationship between exercise task support and perceived usefulness

The elderly are recommended to participate in physical activity regularly as they have an inactive lifestyle, spending more than 9.4 hours a day sedentary (Rosa *et al.*, 2022). Regular exercise helps the elderly maintain better body balance, lowering the risk of injuries from falls by 34% to 54% (Nelson *et al.*, 2007). Thus, the elderly are recommended to exercise regularly such as walking (Muchiri *et al.*, 2018), Tai Chi (Woo *et al.*, 2007), or performing balance exercises (Nelson *et al.*, 2007). In this regard, we argue that when mHealth apps encourage or remind older adults to do exercises regularly, they may manage their health effectively. Thus, we suggest the following hypothesis:

H3: Exercise task support is positively related to the perceived usefulness of mHealth apps.

6.4 Relationship between perceived usefulness and mHealth app adoption intention

The technology acceptance model (TAM) has been widely adopted in various fields to study technology acceptance. In TAM, perceived usefulness is one of the significant determinants of technology adoption and the relationship between perceived useful and intention to adopt is well-tested in healthcare technology adoption (Dou *et al.*, 2017; Kim and Park, 2012; Rajak and Shaw, 2021; Sun *et al.*, 2013). We argue that when users believe using mHealth apps may enhance the effectiveness of their health task management, their intention to adopt mHealth apps is higher. Accordingly, we suggest the following hypothesis:

H4: Perceived usefulness is positively related to user adoption intention of mHealth apps.

6.5 Relationship between perceived usefulness (value barrier) and technology anxiety

Perceived usefulness illustrates how useful is a device in facilitating the accomplishment of goals (Davis, 1989). Prior research showed that perceived usefulness positively impacts the attitude towards the technology, leading to a more favourable attitude and positive emotion formation (Chae, 2010; Ko, Sung, & Yun, 2009). In contrast, according to the study of Yang and Bahli (2015), perceived usefulness may have a greater impact on eliciting higher levels of negative emotion compared to positive emotion, implying that when users perceive technology as not useful, it is likely to provoke a strong negative emotional response. Technology anxiety is one of the emotional responses against adopting technology (Kim *et al.*, 2023). Additionally, the expectation-confirmation model posits that expectation is a baseline of comparison for users to assess the actual performance of the technology. When the actual performance of technology exceeds user expectations, a positive confirmation will occur, which leads to more positive emotion such as satisfaction. In contrast, when it falls below use expectations, users may have negative emotions and attitudes towards the technology (Bhattacherjee, 2001; Leung *et al.*, 2022). Thus, we suggest the following hypothesis:

H5: Perceived usefulness is negatively related to technology anxiety towards mHealth apps.

6.6 Relationship between perceived complexity (usage barrier) and technology anxiety

Unlike perceived ease of use, which refers to the degree to which an individual considers the apps can be used with free effort (Cajita *et al.*, 2017; Pan and Zhao, 2018), complexity is used to measure the degree of effort an individual has to put in using the mHealth apps (Taylor and Todd, 1995). Yang and Bahli (2015) suggest that when users have difficulties in using technology and perceive it is very complex to achieve their goal, they will have higher levels of negative emotion and lower levels of positive emotion. Complexity is a usage barrier for adopting new technology (Rogers *et al.*, 2014). According to cognitive load theory, tasks of greater complexity demand more cognitive effort to manage (Sweller, 2011). It is particularly salient in older adults, whose cognitive abilities decline with age, thereby increasing their anxiety level when learning something new. When users perceive mHealth apps as complicated and regard using them for health task management requires substantial cognitive effort, it can lead to higher levels of anxiety towards mHealth usage. Thus, we propose the following hypothesis:

H6: Perceived complexity is positively related to technology anxiety towards mHealth apps.

6.7 Relationship between perceived security (risk barrier) and technology anxiety

Perceived security in mHealth apps refers to the level of confidence in the apps when delivering sensitive personal information (Octavius and Antonio, 2021). In the e-commerce context, the consumers' perception of web-based security is related to their satisfaction. Chang and Chen (2009) found that when online consumers perceive their personal information is safely transited during the transaction, they will formulate a positive affection such as satisfaction. Additionally, the vulnerability of information systems introduces uncertainty for users, which is often associated with feelings of fear, stress, and anxiety (Workman *et al.*, 2008). Thereby, we argue that when users perceive a low level of security when sending their health information through mHealth apps and regard them as not a safe and secure platform, they will feel more anxious towards mHealth apps. Thus, we propose the following hypothesis:

H7: Perceived security is negatively related to technology anxiety towards mHealth apps.

6.8 Relationship between dispositional resistance to change (tradition barrier) and technology anxiety

According to Bhattacherjee and Hikmet (2007), resistance to change is defined as a generalised opposition to change caused by the perceived adverse consequences. The elderly have a higher tendency to stick with the tradition routine. They are reluctant to change lifestyles and adopt new technology (Guo *et al.*, 2013). In IS literature, when the elderly are introduced to new technology, they respond more saliently to the change as the process of change includes many uncertainties. Thus, most users tend to resist the adoption, which results in low usage intention (Bhattacherjee and Hikmet, 2007). Due to the social inertia, patients are more willing to stick with their existing disease management style. Thus, negative emotions would be provoked when they have to change and adopt healthcare technology (Dou *et al.*, 2017). Besides, when the users are more open-minded, they may have more positive emotions while encountering changes. Reversely, less open-minded people may induce negative emotions while facing changes (Vos, 2006). As the elderly tend to keep their lifestyle and are reluctant to change, their resistance to change may create negative emotional reactions as they worry about encountering new technology (Özdemir-Güngör and Camgöz-Akdağ, 2018). In other words, resistance to change may cause technology anxiety because of the negative emotions induced. Therefore, we argue that since older adults are sensitive to the changes, they are more unwilling to change their existing habits to adopt new technology. Thus, the significant changes will make them feel uncomfortable, anxious, and stressed. Technology anxiety will therefore arise. In this regard, we suggest the following hypothesis:

H8: Dispositional resistance to change is positively related to technology anxiety towards mHealth apps

6.9 Relationship between perceived compatibility (image barrier) and technology anxiety

Compatibility refers to the degree to which an innovation is consistent with past experiences, existing values, and the needs of potential users (Rogers, 2003). Individuals with higher compatibility are more willing to adopt new technology. Research has investigated the relationship between compatibility and the trialability of mHealth apps, it was found that they are positively correlated (Lin and Bautista, 2017). In the context of mHealth, compatibility depends on the user's lifestyle, beliefs, and values. When the mHealth apps do not fit the lifestyles or values of the users, image barrier will exist. Based on the innovation resistance theory (Ram and Sheth, 1989), image barrier arises when the image arises when the innovation is unfavourable to the image of potential users. This barrier is caused by stereotyped thinking. When the mHealth apps are unfavourable to the existing lifestyle of the users or the adoption of the apps is likely to damage the image of users, the image barrier is likely to stop them from adoption. Accordingly, we suggest the following hypothesis:

H9: Perceived compatibility is negatively related to technology anxiety towards mHealth apps.

6.10 Relationship between technology anxiety and mHealth app adoption intention

Technology anxiety is associated with the users' capacity to and desire to adopt IT. This is an emotional aspect that opposes the usage of IT. Previous studies suggested that anxiety is negatively related to the acceptance of IT (Tsai *et al.*, 2020). This anxiety is more significant to elder users. When older users feel anxious about using health technology, they tend to avoid using mHealth apps because of the negative influence (Or and Karsh, 2009). Accordingly, we suggest the following hypothesis:

H10: Technology anxiety towards mHealth apps is negatively related to user adoption intention of mHealth apps.

7. Data collection

To verify the factor structure identified from the EFA, we hired the survey company, Kanter, again for data collection. The targeted respondents were older adults who aged 50 or older and with no experience of using mHealth technology. Older adults with mHealth app experience were excluded from the study because experienced users are likely to have an initial bias about the usability of mHealth apps, which affects the reliability and validity of our study. The online surveys were sent to the targeted respondents in early of Sep 2022. We adopted our self-developed measurement items and other developed scales from the literature to measure the constructs in our research model (Appendix A). A video demonstration and text instructions of two free mHealth apps, namely "My Therapy" and "Mint Health" were provided for respondents before the start of the survey in order to let them get familiar with mHealth apps. Also, these two apps are available on both iOS and Android devices. Respondents were encouraged to download and install the mHealth apps, followed by registration and provision of their personal information. Then, respondents were asked to try the features of the demonstrated mHealth apps by following instructions provided by a video. Based on this initial experience, older adults were required to answer the following questions according to the app viewed in the video demonstration.

7.1 Profile of respondents

After removing invalid responses, 602 respondents were remained. The demographic data are stated in Table 3. The respondents were all from Hong Kong and had no experience in using mobile health apps; 44.3% of them were over 60 years old. The gender distribution of the demographic data were 54.3% men and 45.7% women, with 32.2% having bachelor's degrees. 69.1% of the respondents had been informed by a health professional that they had health conditions or diseases, whereas 26.4% had not received such information. In terms of phone type preference, iPhones we used by 41.5% of the respondents, followed by Xiaomi/Huawei at 35.2%, and Android phones at 23.3%.

=====================

Please insert Table 3.

======================

7.2 Data analysis

A final sample of 602 older adults aged 50 or higher with no experience in using any mHealth apps has been collected to examine the hypotheses in our research framework. PLS-SEM was adopted in analysing the collected data after considering the advantages: (1) It is suitable for analysing research models with complex structures consisting of multiple variables; (2) It is well-suited for studies consisting of direct and indirect relationships; (3) It is suitable for research that aims to examine key external constructs in a research model (Hair *et al.*, 2017). As the goal of this research is to identify key determinants of older adults' perceived usefulness, technology anxiety and mHealth adoption intention in a research model with multiple constructs, using PLS-SEM is appropriate in analysing the data of this study. Thus, we analysed the collected using PLS-SEM, according to the research in the field of technology adoption lately (e.g., (Cheung *et al.*, 2021; Leung *et al.*, 2023; Shi *et al.*, 2024)), which have similar objectives to analyse the collected data using PLS-SEM.

7.2.1 Common method bias (CMB)

As the questionnaire responses were self-evaluated and the samples were collected from a single source, the presence of common method bias (CMB) might have inflated the intensity of the association across the variables. Hence, Harman's single-factor test was conducted to justify the existence of CMB. In this study, no single factor was responsible for more than 37.8% of the variance, which falls below the threshold of 50%, suggesting that CMB was not at a problematic level (Podsakoff, 2003). In addition, we also conducted a full-collinearity assessment following Kock & Lynn's (2012) procedures to assess the potential threat of CMB. We used random numbers to create a dummy variable for a full-collinearity model, and then all variables in the research model were pointed to the dummy variable. As reported in Table 4, the results demonstrated that variance inflation factor (VIF) values ranged from 1.11 to 2.24, being less than the 3.3 threshold, further confirming that CMB was not a potential threat in this research.

======================

Please insert Table 4.

======================

7.2.2 Measurement model results

We examine convergent and discriminant validity using the measurement model. First, the convergent validity of the 13-item, three-factor model was assessed according to the guidelines recommended by Hair et al. (2017). Table 5 presents the measurement model results. The results revealed that the values of the composite reliability, Cronbach's alpha, and factor loading of all items were greater than 0.70, while the values of average variance extracted (AVE) for all factors met the recommended 0.50 threshold. Therefore, the three factors exhibited adequate convergent validity. Discriminant validity was verified according to the Heterotrait–Monotrait (HTMT) ratio criterion (See Table 6), in which all HTMT values ranged between 0.04 to 0.78, being lower the threshold of 0.90 (Henseler *et al.*, 2015), and thus discriminant validity was confirmed.

======================

Please insert Table 5.

======================

======================

Please insert Table 6.

======================

7.2.3 Structural model results

The hypotheses of the structural model were examined by checking the standardised coefficient beta values (β), p-values, and the coefficient of determination (R^2 values). The results supported 8 of the 10 hypotheses (See Figure 2). The model explained 32% of the variance in perceived usefulness, which was significantly predicted by healthy diet task support (β = 0.44, p = 0.00), exercise task support (β = 0.13, p = 0.00) and medical management task support (β = 0.10, p = 0.00), supporting H1, H2, and H3. In addition, the model explained 26% of the variance in technology anxiety, which was significantly predicted by perceived complexity (β = 0.30, p = 0.00) and dispositional resistance to change (β = 0.26, p = 0.00), whilst perceived usefulness has a significant, negative impact on technology anxiety (β = -0.16, p = 0.00), supporting H5, H6, and H8. However, the impacts of perceived security (β = -0.10, p = 0.08) and perceived compatibility (β = 0.07, p = 0.17) on technology anxiety were insignificant, rejecting H7 and H9. Lastly, the model explained 32% of the variance in mHealth app adoption intention, which was significantly predicted by perceived usefulness (β = 0.53, p = 0.00), whilst technology anxiety has a significant and negative impact on mHealth app adoption intention (β = -0.12, p = 0.00). Thus, H4 and H10 are supported.

======================

Please insert Figure 2.

======================

8. Discussion and contributions

8.1. Discussion of results

Guided by innovation resistance theory, the objectives of this study are to develop a new measure of HTMS through a qualitative study, and empirically examine the impacts of drivers and barriers on older adults' adoption intention.

First, all of our newly developed dimensions of HTMS (i.e., medical management task support, dietary task support and exercise task support) exerted a positive effect on perceived usefulness, confirming the importance of our newly developed measures. Unlike solely using perceived usefulness to predict adoption intention, our findings extended the understanding of the antecedents of perceived usefulness, offering fresh insights into mHealth app adoption. When mHealth apps can assist older adults to take medication accurately and on time, remind their medical appointments, maintain healthy eating habits, and regularly work out, they will evaluate mHealth apps as more useful. Subsequently, when older adults find mHealth apps useful, they will have higher levels of positive emotion and lower levels of negative emotion, which in turn increases their willingness to adopt mHealth apps (Yang and Bahli, 2015). This result may be explained by the expectation-confirmation model, which posits that a positive confirmation drives positive emotional reactions such as satisfaction as well as motivates users to use IS (Bhattacherjee, 2001).

Second, our results show that perceived complexity and dispositional resistance to change have the greatest impact on technology anxiety compared to perceived usefulness. However, we found that perceived compatibility and perceived security had insignificant effects on technology anxiety. One common characteristic between perceived complexity and dispositional resistance to change is cognitive demand. When mHealth apps are too complex to use and older adults tend to maintain their status quo and existing belief systems, they need to spend greater cognitive effort to learn and change their habits. Cognitive load theory posits that human cognitive resources are naturally restricted, people tend to avoid demanding their cognitive resources to maintain their optimal status (Sweller, 2011). In particular, older adults have fewer cognitive resources and capacity to process information than younger adults. When these two barriers occur, older adults need to spend substantial cognitive efforts to learn mHealth apps and demand their cognitive resources to change their habits, creating cognitive overload for them. Subsequently, this overload makes them feel anxious and nervous about using mHealth apps.

In addition, the impact of perceived security on technology anxiety is not significant. One possible explanation is that older adults may not pay attention to the potential security threats related to the use of technology. The elderly often lack knowledge about how to securely handle sensitive information. They do not have a sense of danger even if the information is unsecured. Without this awareness, they may not feel anxious particularly associated with security concerns. Finally, perceived compatibility exerted an insignificant effect on technology anxiety. One possible reason is that older adults are stable with self-image (Baker and Gringart, 2009). They are unlikely to be affected by social factors like social pressure. In contrast to younger people, the elderly may be more susceptible to the pressures of social trends. Consequently, using new apps might not lead to discrepancies in their representation or identity. Therefore, perceived compatibility is less likely to cause them concern.

8.2. Theoretical implications

This study sheds light on the literature on mHealth app adoption and older adults' health task management in three different ways. First, this study developed a set of new scales to measure the functions of mHealth apps for assisting health-related tasks often carried out by older adults, which enhances the understanding of the connections between mHealth technological features and older adults' health-related needs. While prior studies have examined the effects of TAM and UTAUT variables on users' adoption of mHealth apps, empirical understanding of mHealth apps functions from a multi-dimensional perspective and the factor structure of its measurement instruments is yet to be explored, and a call for research remains. Seeking to address the knowledge deficiencies, this study has adopted a mixed-method research design to establish a conceptual foundation of HTMS, which provides a holistic view of how mHealth app features help elderly users accomplish their health-related tasks, which drives perceived usefulness of mHealth apps. Based on our literature review and qualitative findings, medication task support, medical appointment task support, dietary task support, and exercise task support have been identified as the key dimensions of HTMS. Subsequently, the content validity of the newly developed 14 measurement items was examined through exploratory factor analysis, which considers HTMS as a multidimensional construct composed of three dimensions. Given that both medication task support and medical appointment task support load onto a single factor, three distinct factors have been identified and retained, namely, medical management task support, dietary task support, and exercise task support. Accordingly, the three identified dimensions of HTMS provide notable values to mHealth technology research for understanding the key functions that older adults are looking for when they are using mHealth apps and which health-related tasks are being supported by mHealth apps, rather than being limited to evaluate the effectiveness of mHealth apps such as perceived usefulness (Shih, 2004). In this manner, this study extends and broadens scholarly understanding by examining the effects of HTMS on other relevant outcomes, including perceived usefulness and its ensuring effects on technology anxiety and adoption intention.

Second, this study answered the call for further investigation in relation to facilitators and barriers to adopting mHealth apps (Trinh *et al.*, 2023). While prior studies have explored drivers of mHealth app adoption based on conventional theories, such as uses and gratification (Lee and Cho, 2017), TAM (Beldad and Hegner, 2018), UTAUT (Hoque and Sorwar, 2017), self-regulation (Hu *et al.*, 2023) and social support (Suh and Li, 2022), this study sheds light on the IRT by accounting for significant barriers that hinder older adults' intention to use mHealth apps through technology anxiety and uncovers the relative importance of barriers in preventing older adults' adoption of mHealth apps. Based on our findings, complexity and dispositional resistance to change were identified as significant barriers influencing technology anxiety, suggesting psychological and functional usage barriers are obstacles to older adults' mHealth adoption. As the understanding of why older adults experience anxiety in response to the use of mHealth apps is still limited, exploring the antecedents of technology anxiety in using mHealth apps provides valuable insights for scholars and developers to better identify effective coping strategies for overcoming these barriers, thereby changing their attitude and perception (Ram and Sheth, 1989).

Third, this research contributes to the IS literature by uncovering the dual process, comprising the perceived usefulness of HTMS (drivers) and technology anxiety (barriers), that drives mHealth adoption. It is also important to note that dimensions of HTMS are vital in reducing technology anxiety through perceived usefulness, suggesting that older adults' technology anxiety is likely to be weakened when they believe that health task management supports provided by mHealth apps are useful in helping them to accomplish health-related tasks and fulfil their health-style-related needs. Our comprehensive findings offer novel insights about how health task management supports drive older adults' adoption intention through the weakening of technology anxiety, which enhances scholarly understanding of mHealth technological success.

8.3. Managerial implications

Our research found that perceived usefulness (value barrier), perceived complexity (usage barrier), and dispositional resistance to change (tradition barrier) have significant effects on technology anxiety. These barriers mediated the technology anxiety of adopting mHealth apps and in turn, negatively impacted the adoption intention of mHealth apps. Healthcare service providers should adopt product strategies to increase the usability of mHealth apps to remove the barriers of value and usage (Ram and Sheth, 1989). To increase the usability, developers should focus on three functions (1) medical management task support, (2) healthy diet task support, and (3) exercise task support. For medical management task support, developers should provide functions that help the elderly record medical appointments and remind them to obtain medication from healthcare providers regularly. mHealth apps should also remind them to take medication as instructed, according to different situations, and on time. For dietary task support, mHealth apps should help the elderly avoid unhealthy food, such as processed foods, indigestible foods, and foods that are high in sugar, salt, and sugar. As suggested by doctors, the elderly should have appropriate nutritional intake, such as fibre and vitamins. Developers should design a function of nutrition analysis to assist the elderly monitor their nutritional intake at every meal. For exercise task support, the elderly perceived it more useful when mHealth apps can remind them to exercise regularly. When the functions are practical and useful in helping the elderly in keeping a healthier lifestyle, the value barrier can be removed. Subsequently, their perception of usefulness and adoption intention would be increased.

Second, to eliminate the usage barrier from the complexity of mHealth apps and encourage the adoption intention, the system complexity and user flow should be simplified. Developers should make the user interface clearer for the elderly as they usually have poor eyesight. Given that older adults may have slower cognitive processing speeds, the design of these apps should prioritise simplicity and ease of use. If mHealth apps are difficult to use, it would discourage them from learning and using them, creating high levels of anxiety. It is recommended that the design of apps should be simple, direct, and clear, which can increase the ease of use of the apps, which in turn increases their adoption rate. Third, tradition barrier provoked by dispositional resistance to change can be addressed through strategies like education and promotion. Marketers and caregivers can host more visiting workshops in elderly centres or organise more home visits to teach the elderly to use mHealth apps. Promoting the benefits and emphasising the health advantages of mHealth apps can encourage their adoption among the elderly. Additionally, more teaching demonstrations in the form of leaflets and videos should be created to educate older adults.

9. Limitation and direction for future research

Despite its meaningful implications, this research has several limitations. First, our research model was examined by data collected using a cross-sectional survey, and thus the generalizability of the findings is limited. Future research could collect longitudinal data to investigate how HTMS dimensions improve older adults' health-related task performance and well-being over time. Second, while this study examined the importance of HTMS dimensions and technology anxiety in driving adoption intention, the model could be further refined to explore the mechanisms involved. Thus, potential moderators, such as social support, task-technology fit, and perceived innovativeness could be added to the model to get more comprehensive findings. Lastly, gender or other demographic factors are considered an important moderator in technology adoption, but it is overlooked in this study. Thus, future research could compare the gender differences in the impact of HTMS and technology anxiety on mHealth app adoption.

Appendix A. Constructs and measurement items

Constructs	Questionnaire items	Sources
Medical management task support (MMTS) - Medication task support (MTS)	Q1-1. [This mHealth app] helps me to obtain medications from hospitals/clinics regularly. Q2-2. [This mHealth app] helps me to take a certain dose of medication as instructed (e.g., 2 capsules each time). Q3-3. [This mHealth app] helps me to take medication according to different situations (e.g., empty stomach/after meals). Q4-4. [This mHealth app] reminds me to take medications on time.	Self-developed
Medical management task support (MMTS) - Medical appointment task support (MATS)	Q5-1. [This mHealth app] helps me to schedule my medical appointment. Q6-2. [This mHealth app] helps me to record my medical appointment (e.g., date and location). *Q7-3. [This mHealth app] helps me to manage my appointments with different doctor specialists.	Self-developed
Dietary task support (DTS)	Q8-1. [This mHealth app] helps me to avoid foods that are high in fat/salt/sugar.	Self-developed

	Q9-2. [This mHealth app] helps me to pay attention to get enough fiber. Q10-3. [This mHealth app] helps me to avoid processed foods (e.g., canned foods or pickled foods). Q11-4. [This mHealth app] helps me to avoid indigestible foods.	
Exercise task support (ETS)	Q12-1. [This mHealth app] helps me to remind myself to do exercise. Q13-2. [This mHealth app] helps me to keep doing exercise. Q14-3. [This mHealth app] helps me to do exercise regularly.	Self-developed
Perceived usefulness (PU)	1. [This mHealth app] is a convenient way to manage my health (e.g. weight or eating habit). 2. [This mHealth app] allows me to manage my health effectively. 3. [This mHealth app] enables me to accomplish my health tasks more quickly.	(Davis, 1989)
Perceived complexity (COM)	1. It will be difficult to learn how to use [this mHealth app]. 2. [This mHealth app] will be frustrating to learn. 3. Using [this mHealth app] requires a lot of mental effort. 4. In general, [this mHealth app] is complex to use.	(Taylor and Todd, 1995)
Dispositional resistance to change (DRC)	1. I don't want to change the way I deal with problems. 2. I don't want to change the way I keep myself. 3. I don't want to change the way I interact with other people.	(Talukder *et al.*, 2020)
Perceived security (PS)	1. I feel secure to perform health tasks using [this mHealth app]. 2. In general, [this mHealth app] is a secure platform through which to send my health information. 3. Overall, [this mHealth app] is a safe place to store my health information.	(Chang and Chen, 2009)
Perceived compatibility (PC)	1. [This mHealth app] is compatible with my image. 2. Using [this mHealth app] fit into my style.	(Moore and Benbasat, 1991)
Technology anxiety (TA)	1. I feel afraid to use [this mHealth app]. 2. I feel nervous about using [this mHealth app]. 3. I feel uncomfortable with [this mHealth app].	(Talukder *et al.*, 2021)
mHealth app adoption intention (INT)	1. If I could, I would like to use [this mHealth app] in the next 4 weeks. 2. All things considered, I expect to use [this mHealth app] in the next 4 weeks. 3. All things considered, it is likely that I will use [this mHealth app] in the next 4 weeks. 4. If I could, I would like to try to use [this mHealth app] in the next 4 weeks.	(Davis, 1989)

*Dropped after EFA in study 1

References:

Abdul Minaam, D.S. and Abd-ELfattah, M. (2018), "Smart drugs: Improving healthcare using Smart Pill Box for Medicine Reminder and Monitoring System", *Future Computing and Informatics Journal*, Vol. 3 No. 2, pp. 443–456, doi: 10.1016/j.fcij.2018.11.008.

Agarwal, R., Gao, G. (Gordon), DesRoches, C. and Jha, A.K. (2010), "The Digital Transformation of Healthcare: Current Status and the Road Ahead", *Information Systems Research*, Vol. 21 No. 4, pp. 796–809, doi: 10.1287/isre.1100.0327.

Ashibani, Y. and Mahmoud, Q.H. (2017), "Cyber physical systems security: Analysis, challenges and solutions", *Computers & Security*, Vol. 68, pp. 81–97.

Askari, M., Klaver, N.S., Van Gestel, T.J. and Van De Klundert, J. (2020), "Intention to use Medical Apps Among Older Adults in the Netherlands: Cross-Sectional Study", *Journal of Medical Internet Research*, Vol. 22 No. 9, p. e18080, doi: 10.2196/18080.

Baker, L. and Gringart, E. (2009), "Body image and self-esteem in older adulthood", *Ageing & Society*, Vol. 29 No. 6, pp. 977–995.

Beldad, A.D. and Hegner, S.M. (2018), "Expanding the Technology Acceptance Model with the Inclusion of Trust, Social Influence, and Health Valuation to Determine the Predictors of German Users' Willingness to Continue using a Fitness App: A Structural Equation Modeling Approach", *International Journal of Human–Computer Interaction*, Vol. 34 No. 9, pp. 882–893, doi: 10.1080/10447318.2017.1403220.

Bergman-Evans, B. (2006), "AIDES to Improving Medication Adherence in Older Adults", *Geriatric Nursing*, Vol. 27 No. 3, p. 9.

Bhattacherjee, A. (2001), "Understanding Information Systems Continuance: An Expectation-Confirmation Model", *MIS Quarterly*, Vol. 25 No. 3, p. 351, doi: 10.2307/3250921.

Bhattacherjee, A. and Hikmet, N. (2007), "Physicians' resistance toward healthcare information technology: a theoretical model and empirical test", *European Journal of Information Systems*, Vol. 16 No. 6, pp. 725–737, doi: 10.1057/palgrave.ejis.3000717.

Birkmeyer, S., Wirtz, B.W. and Langer, P.F. (2021), "Determinants of mHealth success: An empirical investigation of the user perspective", *International Journal of Information Management*, Vol. 59, p. 102351, doi: 10.1016/j.ijinfomgt.2021.102351.

Cajita, M.I., Hodgson, N.A., Budhathoki, C. and Han, H.-R. (2017), "Intention to Use mHealth in Older Adults With Heart Failure", *Journal of Cardiovascular Nursing*, Vol. 32 No. 6, pp. E1–E7, doi: 10.1097/JCN.0000000000000401.

Califf, C.B., Sarker, S. and Sarker, S. (2020), "The bright and dark sides of technostress: A mixed-methods study involving healthcare IT.", *MIS Quarterly*, Vol. 44 No. 2.

Cameron, K. and Richardson, A.W. (2000), "A guide to medication and aging", *Generations*, Vol. 24 No. 4, pp. 8–21.

Camilleri, M.A. (2024), "Factors affecting performance expectancy and intentions to use ChatGPT: Using SmartPLS to advance an information technology acceptance framework", *Technological Forecasting and Social Change*, Vol. 201, p. 123247, doi: 10.1016/j.techfore.2024.123247.

Chang, H.H. and Chen, S.W. (2009), "Consumer perception of interface quality, security, and loyalty in electronic commerce", *Information & Management*, Vol. 46 No. 7, pp. 411–417.

Chen, C.-C., Chang, C.-H. and Hsiao, K.-L. (2022), "Exploring the factors of using mobile ticketing applications: Perspectives from innovation resistance theory", *Journal of Retailing and Consumer Services*, Vol. 67, p. 102974, doi: 10.1016/j.jretconser.2022.102974.

Chen, J.H. and Fu, J.-R. (2018), "On the effects of perceived value in the mobile moment", *Electronic Commerce Research and Applications*, Vol. 27, pp. 118–128, doi: 10.1016/j.elerap.2017.12.009.

Cheung, M.L., Leung, W.K., Chang, L.M. and Shi, S. (2021), "Driving loyalty intentions of mobile games: a motivation theory perspective", *Quality & Quantity*, pp. 1–26.

Chiaranai, C., Chularee, S. and Srithongluang, S. (2018), "Older people living with chronic illness", *Geriatric Nursing*, Vol. 39 No. 5, pp. 513–520, doi: 10.1016/j.gerinurse.2018.02.004.

Davis, F.D. (1989), "Perceived usefulness, perceived ease of use, and user acceptance of information technology", *MIS Quarterly*, pp. 319–340.

Deloitte. (2018), "Global health care sector outlook Infographic".

DiMasi, J.A., Grabowski, H.G. and Hansen, R.W. (2016), "Innovation in the pharmaceutical industry: New estimates of R&D costs", *Journal of Health Economics*, Vol. 47, pp. 20–33, doi: 10.1016/j.jhealeco.2016.01.012.

Dou, K., Yu, P., Deng, N., Liu, F., Guan, Y., Li, Z., Ji, Y., *et al.* (2017), "Patients' Acceptance of Smartphone Health Technology for Chronic Disease Management: A Theoretical Model and Empirical Test", *JMIR mHealth and uHealth*, Vol. 5 No. 12, p. e177, doi: 10.2196/mhealth.7886.

Dreher, M.L. (2018), "Fiber-rich dietary patterns and foods in laxation and constipation", *Dietary Patterns and Whole Plant Foods in Aging and Disease*, Springer, pp. 145–164.

Dute, D.J., Bemelmans, W.J.E. and Breda, J. (2016), "Using Mobile Apps to Promote a Healthy Lifestyle Among Adolescents and Students: A Review of the Theoretical Basis and Lessons Learned", *JMIR mHealth and uHealth*, Vol. 4 No. 2, p. e39, doi: 10.2196/mhealth.3559.

Engelsma, T., Jaspers, M.W.M. and Peute, L.W. (2021), "Considerate mHealth design for older adults with Alzheimer's disease and related dementias (ADRD): A scoping review on usability barriers and design suggestions", *International Journal of Medical Informatics*, Vol. 152, p. 104494, doi: 10.1016/j.ijmedinf.2021.104494.

Esmaeilzadeh, P. (2021), "How does IT identity affect individuals' use behaviors associated with personal health devices (PHDs)? An empirical study", *Information & Management*, Vol. 58 No. 1, p. 103313, doi: 10.1016/j.im.2020.103313.

Faverio, M. (2022), "Share of those 65 and older who are tech users has grown in the past decade", *Pew Research Center*, Vol. 13.

Fox, G. and Connolly, R. (2018), "Mobile health technology adoption across generations: Narrowing the digital divide", *Information Systems Journal*, Vol. 28 No. 6, pp. 995–1019, doi: 10.1111/isj.12179.

Franklin, A. and Myneni, S. (2018), "Engagement and design barriers of mHealth applications for older adults", *Proceedings of the Technology, Mind, and Society*, pp. 1–5.

Garavand, A., Samadbeik, M., Nadri, H., Rahimi, B. and Asadi, H. (2019), "Effective factors in adoption of mobile health applications between medical sciences students using the UTAUT model", *Methods of Information in Medicine*, Vol. 58 No. 04/05, pp. 131–139.

Ghaffari, F., Navabi, N. and Gannat Alipoor, Z. (2016), "Older adults’ attitudes and barriers toward the use of mobile phones", *Clinical Interventions in Aging*, Vol. Volume 11, pp. 1371–1378, doi: 10.2147/CIA.S112893.

Gomes, D., Placido, A.I., Mó, R., Simões, J.L., Amaral, O., Fernandes, I., Lima, F., *et al.* (2020), "Daily medication management and adherence in the polymedicated elderly: A cross-sectional study in Portugal", *International Journal of Environmental Research and Public Health*, Vol. 17 No. 1, p. 200.

Gomez-Gonzalez, J.E. and Reyes, N.R. (2017), "Patterns of global health financing and potential future spending on health", *The Lancet*, Vol. 389 No. 10083, pp. 1955–1956.

Gopal, G., Suter-Crazzolara, C., Toldo, L. and Eberhardt, W. (2019), "Digital transformation in healthcare – architectures of present and future information technologies", *Clinical Chemistry and Laboratory Medicine (CCLM)*, Vol. 57 No. 3, pp. 328–335, doi: 10.1515/cclm-2018-0658.

Greenstein, S., Lerner, J. and Stern, S. (2013), "Digitization, innovation, and copyright: What is the agenda?", *Strategic Organization*, Vol. 11 No. 1, pp. 110–121.

Grundy, Q. (2022), "A Review of the Quality and Impact of Mobile Health Apps", *Annual Review of Public Health*, Vol. 43 No. 1, pp. 117–134, doi: 10.1146/annurev-publhealth-052020-103738.

Guo, X., Sun, Y., Wang, N., Peng, Z. and Yan, Z. (2013), "The dark side of elderly acceptance of preventive mobile health services in China", *Electronic Markets*, Vol. 23 No. 1, pp. 49–61, doi: 10.1007/s12525-012-0112-4.

Haanes, G.G., Hall, E.O.C. and Eilertsen, G. (2019), "Acceptance and adjustment: A qualitative study of experiences of hearing and vision impairments and daily life among oldest old recipients of home care", *International Journal of Older People Nursing*, Vol. 14 No. 3, p. e12236, doi: 10.1111/opn.12236.

Hair, J.F., Black, W.C., Babin, B.J. and Anderson, R.E. (2010), *Multivariate Data Analysis: A Global Perspective*, 7th ed., Pearson, Upper Saddle River, NJ.

Hair, J.F., Hult, G.T.M., Ringle, C.M. and Sarstedt, M. (2017), *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*, Second edition., Sage, Los Angeles.

Helander, E., Kaipainen, K., Korhonen, I. and Wansink, B. (2014), "Factors Related to Sustained Use of a Free Mobile App for Dietary Self-Monitoring With Photography and Peer Feedback: Retrospective Cohort Study", *Journal of Medical Internet Research*, Vol. 16 No. 4, p. e109, doi: 10.2196/jmir.3084.

Henseler, J., Ringle, C.M. and Sarstedt, M. (2015), "A new criterion for assessing discriminant validity in variance-based structural equation modeling", *Journal of the Academy of Marketing Science*, Vol. 43 No. 1, pp. 115–135.

Hew, J.-J., Leong, L.-Y., Tan, G.W.-H., Ooi, K.-B. and Lee, V.-H. (2019), "The age of mobile social commerce: An Artificial Neural Network analysis on its resistances", *Technological Forecasting and Social Change*, Vol. 144, pp. 311–324.

Hillestad, R., Bigelow, J., Bower, A., Girosi, F., Meili, R., Scoville, R. and Taylor, R. (2005), "Can Electronic Medical Record Systems Transform Health Care? Potential Health Benefits, Savings, And Costs", *Health Affairs*, Vol. 24 No. 5, pp. 1103–1117, doi: 10.1377/hlthaff.24.5.1103.

Hoque, R. and Sorwar, G. (2017), "Understanding factors influencing the adoption of mHealth by the elderly: An extension of the UTAUT model", *International Journal of Medical Informatics*, Vol. 101, pp. 75–84.

Horton, S. and Johnson, R.J. (2010), "Improving Access to Health Care for Uninsured Elderly Patients: Access to Health Care for Uninsured Elderly", *Public Health Nursing*, Vol. 27 No. 4, pp. 362–370, doi: 10.1111/j.1525-1446.2010.00866.x.

Hu, J., He, W., Zhang, J.J. and Song, J. (2023), "Examining the Impacts of Fitness App Features on User Well-Being", *Information & Management*, p. 103796, doi: 10.1016/j.im.2023.103796.

Huang, J., Pang, W.S., Wong, Y.Y., Mak, F.Y., Chan, F.S.W., Cheung, C.S.K., Wong, W.N., *et al.* (2022), "Factors Associated With the Acceptance of an eHealth App for Electronic Health Record Sharing System: Population-Based Study", *Journal of Medical Internet Research*, Vol. 24 No. 12, p. e40370, doi: 10.2196/40370.

Istepanian, R.S., Kulhandjian, M. and Chaltikyan, G. (2021), "Mobile Health (mHealth) in the Developing World: Two Decades of Progress or Retrogression", *Journal of the*

International Society for Telemedicine and eHealth, Vol. 8, doi: 10.29086/JISfTeH.8.e24.

Jakovljevic, M., Westerman, R., Sharma, T. and Lamnisos, D. (2021), “Aging and global health”, *Handbook of Global Health*, pp. 73–102.

James, T.L., Deane, J.K. and Wallace, L. (2019), “An application of goal content theory to examine how desired exercise outcomes impact fitness technology feature set selection”, *Information Systems Journal*, Vol. 29 No. 5, pp. 1010–1039, doi: 10.1111/isj.12233.

[redacted]

Kaur, P., Dhir, A., Singh, N., Sahu, G. and Almotairi, M. (2020), “An innovation resistance theory perspective on mobile payment solutions”, *Journal of Retailing and Consumer Services*, Vol. 55, p. 102059, doi: 10.1016/j.jretconser.2020.102059.

Kim, H.-N., Freddolino, P.P. and Greenhow, C. (2023), “Older adults’ technology anxiety as a barrier to digital inclusion: a scoping review”, *Educational Gerontology*, Vol. 49 No. 12, pp. 1021–1038, doi: 10.1080/03601277.2023.2202080.

Kim, J. and Park, H.-A. (2012), “Development of a health information technology acceptance model using consumers’ health behavior intention”, *Journal of Medical Internet Research*, Vol. 14 No. 5, p. e2143.

Klaver, N.S., Van De Klundert, J., Van Den Broek, R.J.G.M. and Askari, M. (2021), “Relationship Between Perceived Risks of Using mHealth Applications and the Intention to Use Them Among Older Adults in the Netherlands: Cross-sectional Study”, *JMIR mHealth and uHealth*, Vol. 9 No. 8, p. e26845, doi: 10.2196/26845.

Knight, T., Yuan, X. and Bennett Gayle, D. (2024), “Illuminating Privacy and Security Concerns in Older Adults’ Technology Adoption”, edited by Xu, H.*Work, Aging and Retirement*, Vol. 10 No. 1, pp. 57–60, doi: 10.1093/workar/waac032.

Kock, N. and Lynn, G. (2012), “Lateral collinearity and misleading results in variance-based SEM: An illustration and recommendations”, *Journal of the Association for Information Systems*, Vol. 13 No. 7.

Kohli, R. and Johnson, S. (2011), “Digital Transformation in Latecomer Industries: CIO and CEO Leadership Lessons from Encana Oil & Gas (USA) Inc.”, *MIS Quarterly Executive*.

Kulkarni, A. and Sathe, S. (2014), “Healthcare applications of the Internet of Things: A Review”, *International Journal of Computer Science and Information Technologies*, Vol. 5 No. 5, pp. 6229–6232.

Laguna, K. and Babcock, R.L. (1997), “Computer anxiety in young and older adults: Implications for human-computer interactions in older populations”, *Computers in Human Behavior*, Vol. 13 No. 3, pp. 317–326.

Laukkanen, T. (2016), “Consumer adoption versus rejection decisions in seemingly similar service innovations: The case of the Internet and mobile banking”, *Journal of Business Research*, Vol. 69 No. 7, pp. 2432–2439.

Laukkanen, T., Sinkkonen, S., Kivijärvi, M. and Laukkanen, P. (2007), “Innovation resistance among mature consumers”, *Journal of Consumer Marketing*, Vol. 24 No. 7, pp. 419–427, doi: 10.1108/07363760710834834.

Lee, H.E. and Cho, J. (2017), “What Motivates Users to Continue Using Diet and Fitness Apps? Application of the Uses and Gratifications Approach”, *Health Communication*, Vol. 32 No. 12, pp. 1445–1453, doi: 10.1080/10410236.2016.1167998.

Lee, P., Aikens, J., Richardson, C., Singer, D., Kirch, M., Solway, E., Smith, E., *et al.* (2022), *Mobile Health App Use Among Older Adults*, University of Michigan National Poll on Healthy Aging.

Leung, W.K., Chang, M.K., Cheung, M.L. and Shi, S. (2023), "VR tourism experiences and tourist behavior intention in COVID-19: an experience economy and mood management perspective", *Information Technology & People*, Vol. 36 No. 3, pp. 1095–1125.

Leung, W.K.S., Chang, M.K., Cheung, M.L. and Shi, S. (2022), "Understanding consumers' post-consumption behaviors in C2C social commerce: the role of functional and relational customer orientation", *Internet Research*, Vol. 32 No. 4, pp. 1131–1167, doi: 10.1108/INTR-11-2020-0664.

Levine, D.M., Lipsitz, S.R. and Linder, J.A. (2016), "Trends in seniors' use of digital health technology in the United States, 2011-2014", *Jama*, Vol. 316 No. 5, pp. 538–540.

Li, J., Zhang, C., Li, X. and Zhang, C. (2020), "Patients' emotional bonding with MHealth apps: An attachment perspective on patients' use of MHealth applications", *International Journal of Information Management*, Vol. 51, p. 102054, doi: 10.1016/j.ijinfomgt.2019.102054.

Lian, J.W. and Yen, D.C. (2014), "Online shopping drivers and barriers for older adults: Age and gender differences", *Computers in Human Behavior*, Vol. 37, pp. 133–143, doi: 10.1016/j.chb.2014.04.028.

Lin, T.T.C. and Bautista, J.R. (2017), "Understanding the Relationships between mHealth Apps' Characteristics, Trialability, and mHealth Literacy", *Journal of Health Communication*, Vol. 22 No. 4, pp. 346–354, doi: 10.1080/10810730.2017.1296508.

Lin, T.T.C., Bautista, J.R. and Core, R. (2020), "Seniors and mobiles: A qualitative inquiry of mHealth adoption among Singapore seniors", *Informatics for Health and Social Care*, Vol. 45 No. 4, pp. 360–373, doi: 10.1080/17538157.2020.1755974.

Liu, H.Y., Lee, W.C., Sun, Y.C., Fen, J.J., Chen, T.J., Chou, L.F. and Hwang, S.J. (2018), "Hospital-Owned Apps in Taiwan: Nationwide Survey", *JMIR mHealth and uHealth*, Vol. 6 No. 1, p. e22, doi: 10.2196/mhealth.8636.

Lv, Q., Jiang, Y., Qi, J., Zhang, Y., Zhang, X., Fang, L., Tu, L., *et al.* (2019), "Using Mobile Apps for Health Management: A New Health Care Mode in China", *JMIR mHealth and uHealth*, Vol. 7 No. 6, p. e10299, doi: 10.2196/10299.

MacPherson, M.M., Merry, K.J., Locke, S.R. and Jung, M.E. (2019), "Effects of Mobile Health Prompts on Self-Monitoring and Exercise Behaviors Following a Diabetes Prevention Program: Secondary Analysis From a Randomized Controlled Trial", *JMIR mHealth and uHealth*, Vol. 7 No. 9, p. e12956, doi: 10.2196/12956.

Mani, Z. and Chouk, I. (2018), "Consumer resistance to innovation in services: challenges and barriers in the internet of things era", *Journal of Product Innovation Management*, Vol. 35 No. 5, pp. 780–807.

McFarland, D.J. and Hamilton, D. (2006), "Adding contextual specificity to the technology acceptance model", *Computers in Human Behavior*, Vol. 22 No. 3, pp. 427–447, doi: 10.1016/j.chb.2004.09.009.

Meng, F., Guo, X., Peng, Z., Lai, K.-H. and Zhao, X. (2019), "Investigating the adoption of mobile health services by elderly users: Trust transfer model and survey study", *JMIR mHealth and uHealth*, Vol. 7 No. 1, p. e12269.

Meng, F., Guo, X., Peng, Z., Ye, Q. and Lai, K.-H. (2022), "Trust and elderly users' continuance intention regarding mobile health services: The contingent role of health and technology anxieties", *Information Technology & People*, Vol. 35 No. 1, pp. 259–280, doi: 10.1108/ITP-11-2019-0602.

Molesworth, M. and Suortti, J. (2002), “Buying cars online: The adoption of the web for high-involvement, high-cost purchases”, *Journal of Consumer Behaviour*, Vol. 2 No. 2, pp. 155–168, doi: 10.1002/cb.97.

Moore, G.C. and Benbasat, I. (1991), “Development of an instrument to measure the perceptions of adopting an information technology innovation”, *Information Systems Research*, Vol. 2 No. 3, pp. 192–222.

Morey, S.A., Stuck, R.E., Chong, A.W., Barg-Walkow, L.H., Mitzner, T.L. and Rogers, W.A. (2019), “Mobile health apps: Improving usability for older adult users”, *Ergonomics in Design*, Vol. 27 No. 4, pp. 4–13.

Morse, J.M., Barrett, M., Mayan, M., Olson, K. and Spiers, J. (2002), “Verification Strategies for Establishing Reliability and Validity in Qualitative Research”, *International Journal of Qualitative Methods*, Vol. 1 No. 2, pp. 13–22, doi: 10.1177/160940690200100202.

Muchiri, W.A., Olutende, O.M., Kweyu, I.W. and Vurigwa, E. (2018), “Meaning of physical activities for the elderly: A review”, *American Journal of Sports Science and Medicine*, Vol. 6 No. 3, pp. 79–83.

Nelson, M., Rejeski, W., Blair, S., Duncan, P., Judge, J., King, A., Macera, C., *et al.* (2007), “American Heart Association Physical activity and public health in older adults: recommendation from the American College of Sports Medicine and the American Heart Association”, *Circulation*, Vol. 116 No. 9, pp. 1094–1105.

Oba, T., Takano, K., Katahira, K. and Kimura, K. (2023), “Use Patterns of Smartphone Apps and Wearable Devices Supporting Physical Activity and Exercise: Large-Scale Cross-Sectional Survey”, *JMIR mHealth and uHealth*, Vol. 11, pp. e49148–e49148, doi: 10.2196/49148.

Octavius, G.S. and Antonio, F. (2021), “Antecedents of intention to adopt mobile health (mHealth) application and its impact on intention to recommend: An evidence from Indonesian customers”, *International Journal of Telemedicine and Applications*, Vol. 2021.

Okuyan, C.B. and Bilgili, N. (2019), “Determining the prevalence of constipation and relating factors in elderly people: A nursing home study”, *Florence Nightingale Journal of Nursing*, Vol. 27 No. 2, pp. 157–165.

Or, C.K.L. and Karsh, B.T. (2009), “A Systematic Review of Patient Acceptance of Consumer Health Information Technology”, *Journal of the American Medical Informatics Association*, Vol. 16 No. 4, pp. 550–560, doi: 10.1197/jamia.M2888.

Osborn, R., Moulds, D., Squires, D., Doty, M.M. and Anderson, C. (2014), “International Survey Of Older Adults Finds Shortcomings In Access, Coordination, And Patient-Centered Care”, *Health Affairs*, Vol. 33 No. 12, pp. 2247–2255, doi: 10.1377/hlthaff.2014.0947.

Özdemir-Güngör, D. and Camgöz-Akdağ, H. (2018), “Examining the effects of technology anxiety and resistance to change on the acceptance of breast tumor registry system: Evidence from Turkey”, *Technology in Society*, Vol. 54, pp. 66–73, doi: 10.1016/j.techsoc.2018.03.006.

Palos-Sanchez, P.R., Saura, J.R., Rios Martin, M.Á. and Aguayo-Camacho, M. (2021), “Toward a Better Understanding of the Intention to Use mHealth Apps: Exploratory Study”, *JMIR mHealth and uHealth*, Vol. 9 No. 9, p. e27021, doi: 10.2196/27021.

Pan, A. and Zhao, F. (2018), “User acceptance factors for mHealth”, presented at the Human-Computer Interaction. Interaction in Context: 20th International Conference, HCI International 2018, Las Vegas, NV, USA, July 15–20, 2018, Proceedings, Part II 20, Springer, pp. 173–184.

Park, J.Y.E., Li, J., Howren, A., Tsao, N.W. and De Vera, M. (2019), “Mobile Phone Apps Targeting Medication Adherence: Quality Assessment and Content Analysis of User Reviews”, *JMIR mHealth and uHealth*, Vol. 7 No. 1, p. e11919, doi: 10.2196/11919.

Pérez-Jover, V., Sala-González, M., Guilabert, M. and Mira, J.J. (2019), “Mobile Apps for Increasing Treatment Adherence: Systematic Review”, *Journal of Medical Internet Research*, Vol. 21 No. 6, p. e12505, doi: 10.2196/12505.

Podsakoff, N. (2003), “Common method biases in behavioral research: A critical review of the literature and recommended remedies”, *Journal of Applied Psychology*, Vol. 885 No. 879, pp. 10–1037.

Pohl, M. (2017), “mHealth App Economics 2017 – current status and future trends in mobile health”.

Rajak, M. and Shaw, K. (2021), “An extension of technology acceptance model for mHealth user adoption”, *Technology in Society*, Vol. 67, p. 101800.

Ram, S. (1987), “A model of innovation resistance”, *ACR North American Advances*.

Ram, S. and Sheth, J.N. (1989), “Consumer Resistance to Innovations: The Marketing Problem and its solutions”, *Journal of Consumer Marketing*, Vol. 6 No. 2, pp. 5–14, doi: 10.1108/EUM0000000002542.

Ree, M., Riediger, N. and Moghadasian, M. (2008), “Factors affecting food selection in Canadian population”, *European Journal of Clinical Nutrition*, Vol. 62 No. 11, pp. 1255–1262.

Ricciardi, W., Pita Barros, P., Bourek, A., Brouwer, W., Kelsey, T., Lehtonen, L., Expert Panel on Effective Ways of Investing in Health (EXPH), *et al.* (2019), “How to govern the digital transformation of health services”, *European Journal of Public Health*, Vol. 29 No. Supplement_3, pp. 7–12, doi: 10.1093/eurpub/ckz165.

Rogers, E.M., Singhal, A. and Quinlan, M.M. (2014), “Diffusion of innovations”, *An Integrated Approach to Communication Theory and Research*, Routledge, pp. 432–448.

Rosa, M., Antunes, R., Marques, P., Coelho, R., Mendes, P. and Frontini, R. (2022), “A narrative exploratory study on the perspectives about physical exercise practise in a sample of Portuguese elderly”, *Quality & Quantity*, doi: 10.1007/s11135-022-01380-2.

Ruhi, U., Majedi, A. and Chugh, R. (2021), “Sociotechnical Drivers and Barriers in the Consumer Adoption of Personal Health Records: Empirical Investigation”, *JMIR Medical Informatics*, Vol. 9 No. 9, p. e30322, doi: 10.2196/30322.

Sadeghi R., J.K., Prybutok, V.R. and Sauser, B. (2022), “Theoretical and practical applications of blockchain in healthcare information management”, *Information & Management*, Vol. 59 No. 6, p. 103649, doi: 10.1016/j.im.2022.103649.

Schneider, S. and Kokshagina, O. (2021), “Digital transformation: What we have learned (thus far) and what is next”, *Creativity and Innovation Management*, Vol. 30 No. 2, pp. 384–411, doi: 10.1111/caim.12414.

Sezgin, E., Özkan-Yildirim, S. and Yildirim, S. (2017), “Investigation of physicians’ awareness and use of mHealth apps: A mixed method study”, *Health Policy and Technology*, Vol. 6 No. 3, pp. 251–267, doi: 10.1016/j.hlpt.2017.07.007.

Sheth, J.N. (1981), “Innovation resistance. The less developed concept (LDC) in diffusion research”, *Research in Marketing*, Vol. 4 No. 3, pp. 273–282.

Shi, S., Leung, W.K. and Munelli, F. (2022), “Gamification in OTA platforms: A mixed-methods research involving online shopping carnival”, *Tourism Management*, Vol. 88, p. 104426.

Shi, S., Zhao, H., Li, H., Zhang, M. and Leung, W.K.S. (2024), “Investigating challenge and hindrance appraisals of enterprise social media use among hospitality employees: A technostress perspective”, *Tourism Management*, Vol. 100, p. 104814, doi: 10.1016/j.tourman.2023.104814.

Shih, H.-P. (2004), “An empirical study on predicting user acceptance of e-shopping on the Web”, *Information & Management*, Vol. 41 No. 3, pp. 351–368, doi: 10.1016/S0378-7206(03)00079-X.
Shih, H.-P. (2008), “Using a cognition-motivation-control view to assess the adoption intention for Web-based learning”, *Computers & Education*, Vol. 50 No. 1, pp. 327–337, doi: 10.1016/j.compedu.2006.06.001.
Stockman, J.A. (2006), “Effects of Computerized Clinical Decision Support Systems on Practitioner Performance and Patient Outcomes: A Systematic Review”, *Yearbook of Pediatrics*, Vol. 2006, pp. 293–295, doi: 10.1016/S0084-3954(07)70181-1.
Suh, A. and Li, M. (2022), “How the use of mobile fitness technology influences older adults’ physical and psychological well-being”, *Computers in Human Behavior*, Vol. 131, p. 107205, doi: 10.1016/j.chb.2022.107205.
Sun, Y., Wang, N., Guo, X. and Peng, Z. (2013), “Understanding the acceptance of mobile health services: a comparison and integration of alternative models”, *Journal of Electronic Commerce Research*, Vol. 14 No. 2, p. 183.
Sweller, J. (2011), “Cognitive load theory”, *Psychology of Learning and Motivation*, Vol. 55, Elsevier, pp. 37–76.
Talukder, Md.S., Laato, S., Islam, A.K.M.N. and Bao, Y. (2021), “Continued use intention of wearable health technologies among the elderly: an enablers and inhibitors perspective”, *Internet Research*, Vol. 31 No. 5, pp. 1611–1640, doi: 10.1108/INTR-10-2020-0586.
Talukder, Md.S., Sorwar, G., Bao, Y., Ahmed, J.U. and Palash, Md.A.S. (2020), “Predicting antecedents of wearable healthcare technology acceptance by elderly: A combined SEM-Neural Network approach”, *Technological Forecasting and Social Change*, Vol. 150, p. 119793, doi: 10.1016/j.techfore.2019.119793.
Taylor, A.W. (2021), *Physiology of Exercise and Healthy Aging*, Human Kinetics.
Taylor, S. and Todd, P. (1995), “Understanding Household Garbage Reduction Behavior: A Test of an Integrated Model”, *Journal of Public Policy & Marketing*, Vol. 14 No. 2, pp. 192–204, doi: 10.1177/074391569501400202.
Tong, C., Kernoghan, A., Lemmon, K., Fernandes, P., Elliott, J., Sacco, V., Bodemer, S., *et al.* (2022), “Lessons and Reflections From an Extended Co-design Process Developing an mHealth App With and for Older Adults: Multiphase, Mixed Methods Study”, *JMIR Aging*, Vol. 5 No. 4, p. e39189, doi: 10.2196/39189.
Topol, E. (2015), *The Patient Will See You Now: The Future of Medicine Is in Your Hands*, Basic Books.
Trinh, M., Harris, M.T., Azevedo, R.F.L. and Rogers, W.A. (2023), “Understanding older adults’ perceptions of mHealth apps”, *Gerontechnology*, Vol. 22 No. 1, pp. 1–7, doi: 10.4017/gt.2023.22.1.841.10.
Tsai, T.-H., Lin, W.-Y., Chang, Y.-S., Chang, P.-C. and Lee, M.-Y. (2020), “Technology anxiety and resistance to change behavioral study of a wearable cardiac warming system using an extended TAM for older adults”, edited by Borsci, S.*PLOS ONE*, Vol. 15 No. 1, p. e0227270, doi: 10.1371/journal.pone.0227270.
Vaghefi, I. and Tulu, B. (2019), “The continued use of mobile health apps: insights from a longitudinal study”, *JMIR mHealth and uHealth*, Vol. 7 No. 8, p. e12983.
Venkatesh, V., Brown, S. and Sullivan, Y. (2016a), “Guidelines for Conducting Mixed-methods Research: An Extension and Illustration”, *Journal of the Association for Information Systems*, Vol. 17 No. 7, pp. 435–494, doi: 10.17705/1jais.00433.
Venkatesh, V., Brown, S.A. and Bala, H. (2013), “Bridging the qualitative-quantitative divide: Guidelines for conducting mixed methods research in information systems”, *MIS Quarterly*, pp. 21–54.

Venkatesh, V., Brown, S.A. and Sullivan, Y. (2016b), "Guidelines for conducting mixed-methods research: An extension and illustration", *Venkatesh, V., Brown, SA, and Sullivan, YW'Guidelines for Conducting Mixed-Methods Research: An Extension and Illustration,'Journal of the AIS (17: 7)*, pp. 435–495.

Vergouw, J.W., Smits-Pelser, H., Kars, M.C., Van Houwelingen, T., Van Os-Medendorp, H., Kort, H. and Bleijenberg, N. (2020), "Needs, barriers and facilitators of older adults towards eHealth in general practice: a qualitative study", *Primary Health Care Research & Development*, Vol. 21, p. e54, doi: 10.1017/S1463423620000547.

Vial, G. (2019), "Understanding digital transformation: A review and a research agenda", *The Journal of Strategic Information Systems*, Vol. 28 No. 2, pp. 118–144, doi: 10.1016/j.jsis.2019.01.003.

Vos, J. (2006), *The Role of Personality and Emotions in Employee Resistance to Change*, Rotterdam: Erasmus University Rotterdam. (Studi Empiris pada Mahasiswa Universitas Swasta X di Jakarta).

Voth, E.C., Oelke, N.D. and Jung, M.E. (2016), "A Theory-Based Exercise App to Enhance Exercise Adherence: A Pilot Study", *JMIR mHealth and uHealth*, Vol. 4 No. 2, p. e62, doi: 10.2196/mhealth.4997.

Vroman, K.G., Arthanat, S. and Lysack, C. (2015), "'Who over 65 is online?' Older adults' dispositions toward information communication technology", *Computers in Human Behavior*, Vol. 43, pp. 156–166, doi: 10.1016/j.chb.2014.10.018.

Wang, Q., Liu, J., Zhou, L., Tian, J., Chen, X., Zhang, W., Wang, H., *et al.* (2022), "Usability evaluation of mHealth apps for elderly individuals: a scoping review", *BMC Medical Informatics and Decision Making*, Vol. 22 No. 1, p. 317, doi: 10.1186/s12911-022-02064-5.

Wang, Y., Wu, T. and Chen, Z. (2021), "Active Usage of Mobile Health Applications: Cross-sectional Study", *Journal of Medical Internet Research*, Vol. 23 No. 12, p. e25330, doi: 10.2196/25330.

West, J.H., Belvedere, L.M., Andreasen, R., Frandsen, C., Hall, P.C. and Crookston, B.T. (2017), "Controlling Your 'App'etite: How Diet and Nutrition-Related Mobile Apps Lead to Behavior Change", *JMIR mHealth and uHealth*, Vol. 5 No. 7, p. e95, doi: 10.2196/mhealth.7410.

Wisten, A. and Messner, T. (2005), "Fruit and fibre (Pajala porridge) in the prevention of constipation", *Scandinavian Journal of Caring Sciences*, Vol. 19 No. 1, pp. 71–76.

Woo, J., Hong, A., Lau, E. and Lynn, H. (2007), "A randomised controlled trial of Tai Chi and resistance exercise on bone health, muscle strength and balance in community-living elderly people", *Age and Ageing*, Vol. 36 No. 3, pp. 262–268.

Workman, M., Bommer, W.H. and Straub, D. (2008), "Security lapses and the omission of information security measures: A threat control model and empirical test", *Computers in Human Behavior*, Vol. 24 No. 6, pp. 2799–2816, doi: 10.1016/j.chb.2008.04.005.

World Health Organization. (2018), "NCD mortality and morbidity".

Xi, W., Zhang, X. and Ayalon, L. (2022), "When less intergenerational closeness helps: The influence of intergenerational physical proximity and technology attributes on technophobia among older adults", *Computers in Human Behavior*, Vol. 131, p. 107234, doi: 10.1016/j.chb.2022.107234.

Xu, C., Peak, D. and Prybutok, V. (2015), "A customer value, satisfaction, and loyalty perspective of mobile application recommendations", *Decision Support Systems*, Vol. 79, pp. 171–183, doi: 10.1016/j.dss.2015.08.008.

Yang, I. and Bahli, B. (2015), "Interplay of cognition and emotion in IS usage: Emotion as mediator between cognition and IS usage", *Journal of Enterprise Information Management*, Vol. 28 No. 3, pp. 363–376, doi: 10.1108/JEIM-12-2013-0092.

Yang, X.-J., Zhang, M., Zhu, H.-M., Tang, Z., Zhao, D.-D., Li, B.-Y. and Gabriel, A. (2016), "Epidemiological study: correlation between diet habits and constipation among elderly in Beijing region", *World Journal of Gastroenterology*, Vol. 22 No. 39, p. 8806.

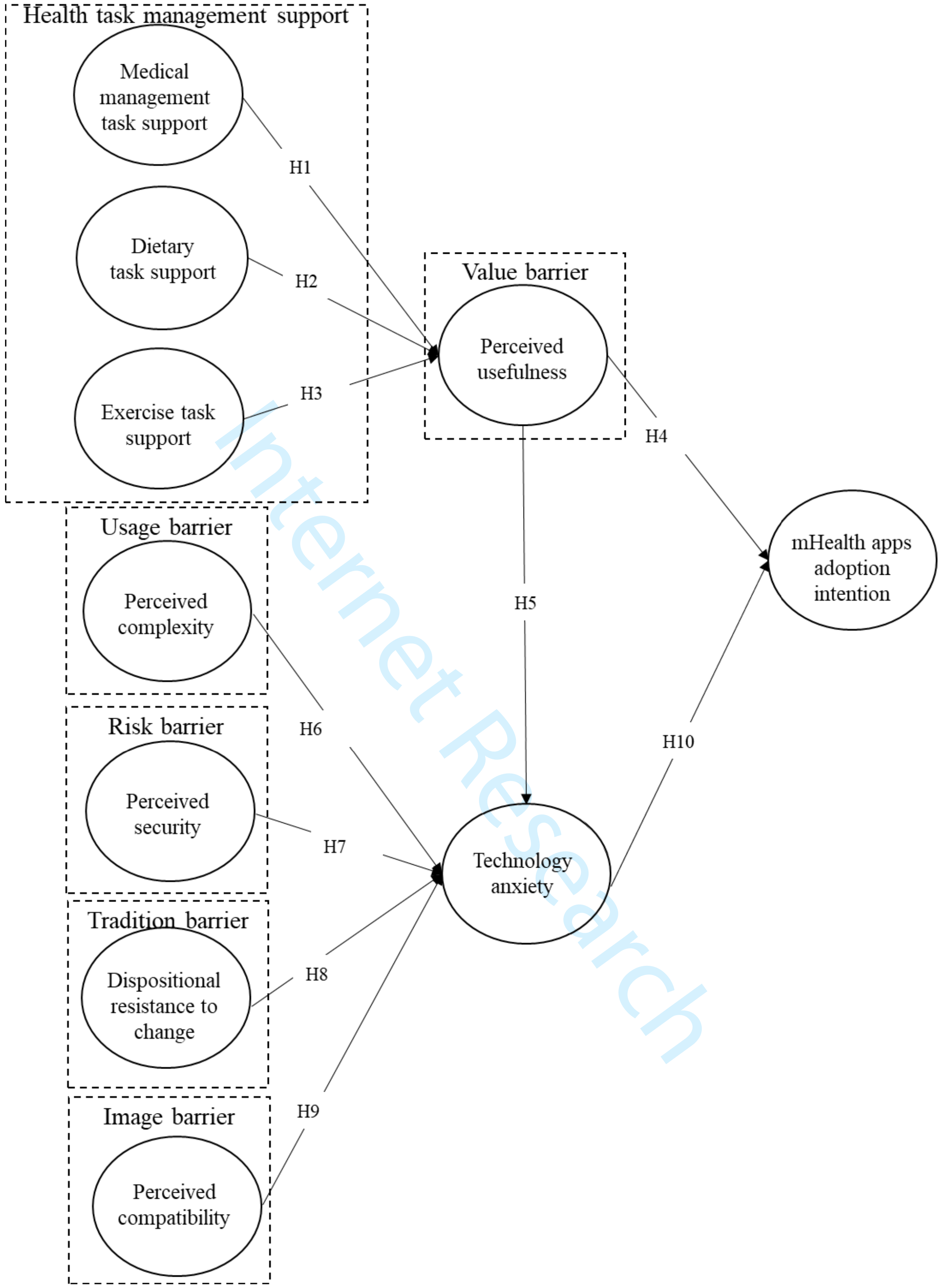

Figure 1. Research model

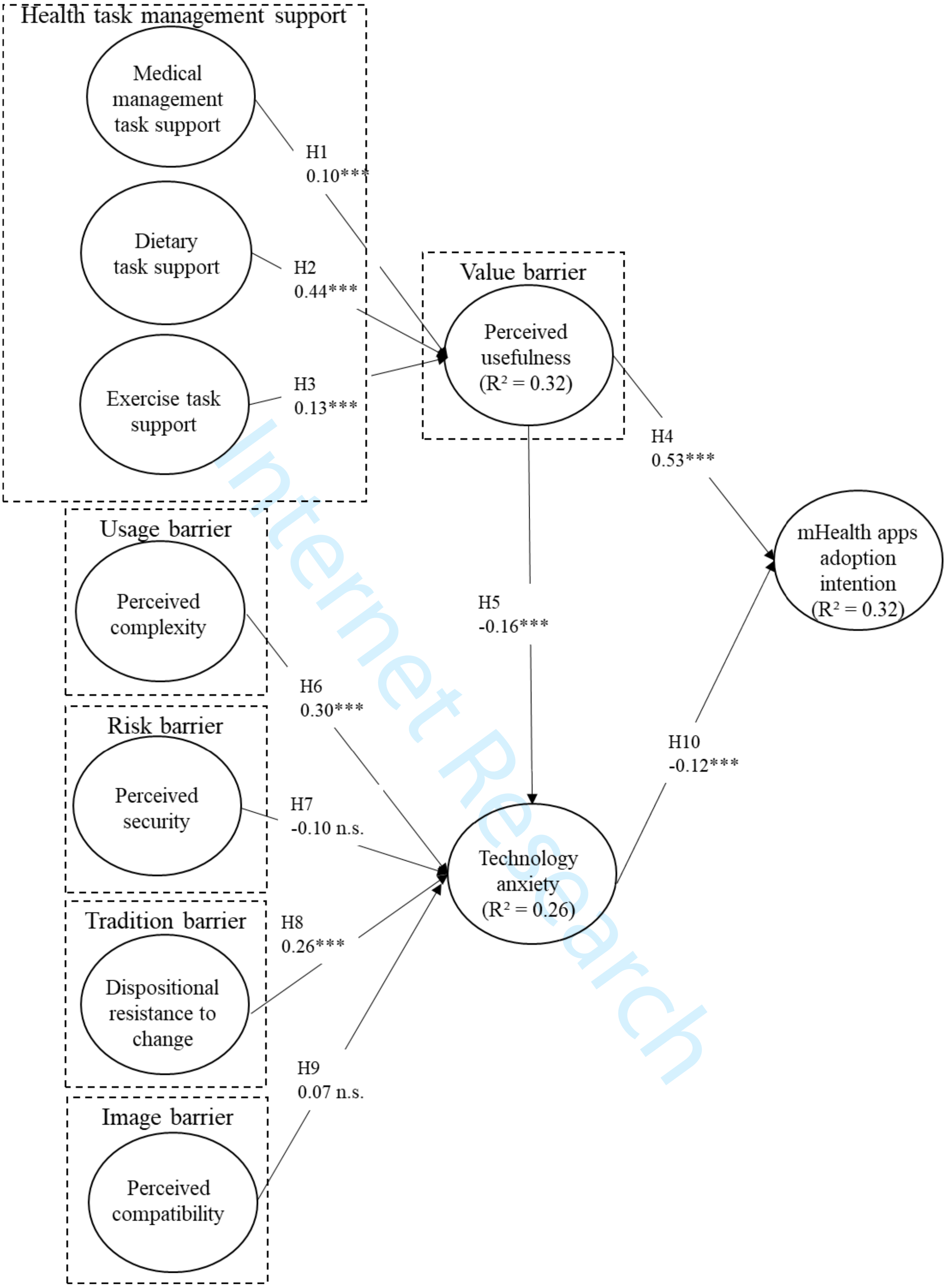

Figure. 2. Structural model testing results

Table 1. Qualitative analysis of health task management for the elderly

Health-related tasks	Definition	Examples from interview	Examples from literature	Scale	Examples from mHealth apps
Medication task	Elderly people need to take their medication according to specific times, doses, and situations as well as go to hospitals or clinics to get medicine on a regular basis.	1. About once a month, when I have almost finished my medication, I have to get more medicine by going to the hospital. 2. I visit the hospital every three months to obtain sufficient medication. 3. I need to control my medication doses depending on my condition. Whenever my blood pressure is a little higher than usual, I normally take half a pill. However, I occasionally need to take one and a half tablets to lower my blood pressure when it is really high. 4. Sometimes I must take medication on an empty stomach and other times I have	1. When people get older, they typically acquire chronic diseases in which medications are often the primary therapy technique. More than 60% of elderly people have two or more chronic conditions (Bergman-Evans, 2006). Older people frequently get medicine from medical centres and, as a result, they develop the habit of relying on multiple medications (Cameron & Richardson, 2000). 2. In general, medication consumption is high among the frail elderly (Collamati et al., 2016). Over 40% of people who are aged 65 or above take five prescription drugs daily (Kulkarni & Sathe, 2014). As instructed by doctors, they often need to take a variety of medicines according to different situations (Abdul Minaam & Abd-ELfattah, 2018). 3. Since aging causes both poor memory and vision, elderly people can easily forget to take their medication at the correct time, fail to remember which medications to take or even	1. obtain medications from hospitals/clinics regularly. 2. take a certain dose of medication as instructed. 3. take medication according to different situations (e.g., empty stomach/after meals). 4. remind to take my	My therapy: Users need to input the name of the medication and enter the dosage, time, and date of intake. Users receive an auditory prompt from the application when it's time to take their medication, as it's programmed to sound an alert at the designated times. Medisafe Pill Reminder: Users can rely on Medisafe for timely medication reminders, ensuring they never miss a dose, even when their device is in sleep

		to eat after a full meal due to the various properties of the medicine. 5. To remember to take my medication on schedule, I need a medicine box that separates my morning, noon and night-time blood pressure control medications. 6. I frequently worry about forgetting to take my medication so I wish I could have someone to remind me to take it on time.	confuse one pill with another (Abdul Minaam & Abd-ELfattah, 2018). According to Gomes et al. (2020), about 39% of the elderly frequently miss their medication schedule or take inaccurate doses due to forgetfulness. As a consequence, taking medication is challenging.	medication on time.	mode. With built-in time zone support, travellers can have peace of mind knowing their medication alerts will always be punctual, no matter where they are.
Medical appointment task	Elderly people need to arrange their own medical appointments according to their needs.	1. I have to schedule appointments for follow-up care in advance as I do not live close to the hospital. 2. I have to visit different specialists. However, as you know, specialists have very busy schedules especially for arranging CT scans, so I must	1. Elderly people with multimorbidity need to visit different healthcare facilities for regular check-ups (Osborn et al., 2014). They have to call up and schedule their medical appointments with different specialists. However, it can take elderly people at least one month to get an appointment as medical specialists are often booked far in advance. As a result, the older generation often forget to attend appointments (Hinton et al., 2007).	1. schedule my medical appointment. 2. record my medical appointment (e.g., date and location).	My therapy: Users have access to a medical/clinical appointment scheduling feature, which allows them to input details for upcoming appointments. This includes the ability to

	go to multiple locations on different days to attend medical appointments, and this can be perplexing at times. 3. Sometimes the hospital schedules a follow-up appointment for 1-2 years in advance therefore I need to jot down the date as soon as possible to avoid forgetting. 4. As I have multiple medical conditions, including high blood pressure, diabetes, and foot discomfort, I need to consult different medical specialists. I am always concerned that I will forget to attend an appointment at a specific time, day, or location. Therefore, I always note down the time, place, and names of the specialists in my calendar.	2. Older adults have difficulties with medical appointments such as scheduling, arranging transportation, and keeping healthy. (Horton & Johnson, 2010). Sometimes they miss appointments due to a lack of assistance from family and friends (Wang et al., 2014). 3. Visiting multiple doctors or different medical centres is the norm for the elderly and this becomes more common with age. Older people are accustomed to seeking health treatment from different specialists. The most common situation is two visits per day. Some elderly people even see doctors seven times a day (Kuo et al., 2014).	3. manage my appointments with different doctor specialists.	log the date and time of the appointment, the location of the consultation, and the time when they would like to receive a reminder. Medisafe Pill Reminder: Users receive reminders for their medical/clinical appointments.

		5. Sadly, I have a poor memory due to my advanced age. I always forget to visit the hospital for follow-up consultations, and I only realize this once the nurse contacts me. Therefore, now I record every appointment on my mobile phone.			
Exercise task	Elderly people need regular exercise to stay healthy.	1. My doctor has advised me to do morning exercises such as Tai Chi at least three times a week for a minimum of 30 minutes to enhance my physical strength and cardiorespiratory endurance. 2. My friends and relatives often tell me that I should do more exercise to strengthen my balance as it is easy for the elderly to fall down. 3. On my feet, I began to feel powerless because of aging, so my friends advised me to	1. An inactive lifestyle is more common in older adults, as they spend more than 9.4 hours a day sedentary. Hence, seniors should be reminded to maintain a routine of performing regular physical activity as they get older (Rosa et al., 2022). 2. Regular exercise with rhythmic muscle movements is good for elderly people as their blood pressure can be managed properly (Taylor, 2021). Moreover, frequent exercise enhances bone mineral density, moderates pain (Mora & Valencia, 2018), reduces cardiovascular disease (Muchiri et al., 2018), and alleviates the effect of sarcopenia. (Woo et al., 2007).	1. remind myself to do exercise. 2. keep doing exercise. 3. do exercise regularly.	My therapy: Users can choose the intended exercise activity. Fill in the duration of the activity, date, and time, followed by recording the details. The exercise times for the week can be reviewed. Users can set up exercise reminders through a dedicated feature that alerts them at their specified reminder time. When this time arrives, a notification

		strengthen my muscles through physical activity. 4. In accordance with the doctor's advice, I walk for 30 minutes in the park every day in order to prevent the loss of muscle mass. 5. I went to the doctor a few years ago due to an ongoing ache in my waist. The doctor suggested that I try swimming. Come rain or shine I insist on going swimming every day. As a result, the pain in my waist is improving.	3. Regular exercise enables the elderly to maintain better body balance, and, as a result, the risk of fractures and injuries from falls, is reduced between 35 to 54% (Nelson et al., 2007). Thus, the elderly are encouraged to undertake regular exercise such as walking (Muchiri et al., 2018), Tai Chi (Woo et al., 2007), or performing balance exercises (Nelson et al., 2007). 4. In addition to physical health, doing exercise on a regular basis can alleviate levels of depression and anxiety, as well as reduce the risk of cognitive decline, thereby enhancing mental health in the elderly. (Galloza et al., 2017; Rosa et al., 2022).		is promptly displayed, ensuring that users receive a timely reminder to carry out their planned exercise activity. Mint Health: Users can monitor their physical activity using the exercise tracking feature of the app, which logs the duration of their selected workout. This data allows the app to estimate the remaining caloric intake users are allowed for the day.
Dietary task	Elderly people need to pay attention to their diet to	1. It is often asserted that we as the elderly should consume less fried food in order to prevent hyperlipidemia.	1. Since lots of older adults suffer from chronic illnesses such as hypertension and diabetes mellitus, in order to manage these conditions, doctors suggest that they should avoid consuming food which is high in fat, salt (Ree et al., 2008), or sugar (Chiaranai et al., 2018).	1. avoid foods that are high in fat/salt/sugar.	Mint Health: Users can choose two different types of food and then compare their nutritional components. Also, the

	maintain good health.	2. The doctor has warned me not to consume sugar-rich meals like tofu pudding since I am prone to diabetes at this age. 3. I need to eat foods high in fiber, like fruits and vegetables, to help me defecate since, we, the elderly people have weak stomachs. 4. My daughter advised me to stay away from eating a lot of canned food like luncheon meat and diced fish in black bean sauce as they contain a lot of chemical additives. 5. The doctor advised me to avoid eating a lot of foods that are difficult to digest, including sticky rice, taro, or rice dumplings. It is normal for older people to have stomach discomfort after consuming these dishes since these foods	2. According to Rome II constipation diagnosis criteria, more than half of the elderly suffer from constipation problems (Okuyan & Bilgili, 2019). However, adequate intake of dietary fibre is beneficial in terms of alleviating and preventing constipation (Dreher, 2018). Therefore, older people are recommended to follow a diet with high fibre intake, such as vegetables, fruits and fibre-rich porridge (Wisten & Messner, 2005; Yang et al., 2016). 3. Older adults have weaker renal function, and excessive consumption of processed food can lead to chronic kidney disease and cardiovascular disease (Martins et al., 2017). Doctors suggest adopting dietary patterns with a high contribution of natural food (Pereira et al., 2020). 4. Older adults are likely to have digestion problems or have difficulty chewing food properly due to either dental problems or side effects from medications which slow gastrointestinal motility (Nakarmi et al., 2020).	2. pay attention to get enough fiber. 3. avoid processed foods (e.g., canned foods or pickled foods). 4. avoid indigestible foods.	app records users' dietary logs to see approximately how many calories have been consumed. My Fitness Pal: Users can monitor their calorie intake as well as help them set realistic health goals.

	are challenging for their digestion systems.	Doctors recommend the elderly to avoid eating indigestible food.

Table 2. Exploratory factor analysis for a reduced set of health task management support items (Q7 is dropped)

Item number	Promax-rotated loadings factor			Communality
	1	2	3	
Q1-Medication task support 1	0.84			0.72
Q2-Medication task support 2	0.85			0.72
Q3-Medication task support 3	0.88			0.76
Q4-Medication task support 4	0.81			0.74
Q5-Medical appointment task support 1	0.72			0.71
Q6-Medical appointment task support 2	0.76			0.71
Q8-Dietary task support 1		0.80		0.83
Q9-Dietary task support 2		0.83		0.85
Q10-Dietary task support 3		0.89		0.81
Q11-Dietary task support 4		0.89		0.73
Q12-Exercise task support 1			0.83	0.78
Q13-Exercise task support 2			0.73	0.83
Q14-Exercise task support 3			0.81	0.72
Sum of squares (eigenvalue)	6.52	2.35	1.07	9.94
Percentage of variance explained	50.2	18.1	8.2	76.5

Factor loadings lower than 0.4 were suppressed.

Table 3. Demographic characteristics (N=602)

Attributes	Category	Frequency	Percentage
Please indicate if you have ever been told by a health professional that you have any of diseases	Yes	416	69.1
	No	159	26.4
	Do not wish to answer	6	1.0
	Not sure	21	3.5
Gender	Male	327	54.3
	Female	275	45.7
Age	50-54	148	24.6
	55-59	187	31.1
	60-64	132	21.9
	65-69	67	11.1
	70-74	37	6.1
	75-79	16	2.7
	80-84	14	2.3
	Above 85	1	0.2
Education	Primary school or below	74	12.3
	Junior high school	116	19.3
	Senior high school	193	32.1
	Bachelor's degree	194	32.2
	Master's degree or above	25	4.2
	iPhone	250	41.5
Phone type	Android	140	23.3
	Xiaomi/Huawei	212	35.2

Table 4. Common method bias: Full collinearity assessment

Variables	VIF values for random-number dummy variable
Dispositional Resistance to Change	1.32
Exercise Task Support	1.39
Healthy Diet Task Support	1.85
Medical Management Task Support	1.12
Perceived Compatibility	1.11
Perceived Complexity	1.29
Perceived Security	1.89
Perceived Usefulness	1.58
Technology Anxiety	1.33
mHealth App Adoption Intention	2.24

Table 5. Reliability and validity

Constructs	Items	Factor Loading	Mean
Medical management	MMTS1 (Q1)	0.79	5.12
task support (MMTS)	MMTS2 (Q2)	0.85	4.72
CR = 0.94, AVE = 0.71,	MMTS3 (Q3)	0.87	4.90
Alpha = 0.92	MMTS4 (Q4)	0.86	4.92
	MMTS5 (Q5)	0.85	4.89
	MMTS6 (Q6)	0.86	5.07
Dietary task support	DTS1 (Q8)	0.88	4.62
(DTS)	DTS2 (Q9)	0.90	4.77
CR = 0.93, AVE = 0.78,	DTS3 (Q10)	0.92	4.73
Alpha = 0.91	DTS4 (Q11)	0.84	4.66
Exercise task support	ETS1 (Q12)	0.83	4.89
(ETS)	ETS2 (Q13)	0.88	4.77
CR = 0.90, AVE = 0.76,	ETS3 (Q14)	0.90	4.88
Alpha = 0.84			
Perceived usefulness	PU1	0.81	4.58
(PU)	PU2	0.91	4.82
CR = 0.91, AVE = 0.77,	PU3	0.91	4.84
Alpha = 0.85			
Perceived complexity	COM1	0.89	3.96
(COM)	COM2	0.87	3.64
CR = 0.94, AVE = 0.79,	COM3	0.89	4.27
Alpha = 0.91	COM4	0.90	4.20
Dispositional resistance	DRC1	0.90	3.98
to change	DRC2	0.90	4.22
(DRC)	DRC3	0.90	4.21
CR = 0.93, AVE = 0.82,			
Alpha = 0.89			
Perceived security (PS)	PS1	0.87	5.01
CR = 0.93, AVE = 0.81,	PS2	0.92	4.82
Alpha = 0.89	PS3	0.92	4.89
Perceived compatibility	PC1	0.94	5.08
(PC)	PC2	0.93	4.97
CR = 0.93, AVE = 0.87,			
Alpha = 0.86			
Technology anxiety (TA)	TA1	0.90	3.44
CR = 0.93, AVE = 0.85,	TA2	0.90	3.74
Alpha = 0.89	TA3	0.91	3.40
	INT1	0.92	4.62

mHealth app adoption	INT2	0.93	4.75
intention	INT3	0.93	4.69
(INT)	INT4	0.91	4.79
CR = 0.96, AVE = 0.85,			
Alpha = 0.94			

Table 6. Discriminant validity: HTMT ratio

	DRC	ETS	DTS	MMTS	PC	COM	PS	PU	TA	INT
DRC										
ETS	0.04									
DTS	0.12	0.59								
MMTS	0.05	0.34	0.32							
PC	0.20	0.55	0.66	0.34						
COM	0.42	0.06	0.16	0.15	0.22					
PS	0.21	0.42	0.62	0.39	0.78	0.12				
PU	0.07	0.46	0.61	0.30	0.62	0.10	0.55			
TA	0.43	0.12	0.25	0.03	0.21	0.45	0.23	0.23		
INT	0.23	0.48	0.63	0.45	0.82	0.23	0.75	0.61	0.24	