# Acceptance of mobile health applications for obesity in Saudi Arabia

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## Abstract

Obesity is now acknowledged to be a global challenge, leading to serious consequences for the health of individuals and potentially creating a heavy burden for national health services. The countries of the Arabian Gulf are particularly affected by the spread of obesity, and a third of the population of Saudi Arabia is now judged to be obese. However, Saudi Arabia, despite its oil wealth, is a developing country faced with numerous economic, political and social challenges. The ability of the country's healthcare sector to counter this trend is affected by the country's dilapidated transport network, suppression of women's rights, the existence of many foreign nationals and the fact that many Saudis live far from centres where health care is available. On the other hand, the country has a very high mobile phone penetration, coupled with a high ownership of smart phones. This has led to a growth in Internet usage in recent years and a rising demand on mobile broadband services. As health-oriented products and services are a popular genre of mobile application, they may have the potential to mitigate the global obesity trend in the country.

Extensive applications in mHealth are being used globally with some success, particularly in the areas of personal fitness and the trend towards life-blogging or the Quantified Self. However, Saudi Arabia is a very specific geographical, social and cultural context. This study aims to fill the knowledge gap in the literature about how such mHealth applications might be accepted by young Saudi citizens, using the consumer-oriented version of the well-known technology acceptance model. Potential users as well as current users of health apps were interviewed in focus group settings and a questionnaire was developed based on the UTAUT2 model.

The findings from these studies reflect both on the potential for mHealth in combatting obesity and on the details of the UTAUT2 model used. There was general acceptance of the potential usefulness (Performance Expectancy) of mobile apps, and an expectation that these apps would be easy to use (Effort Expectancy). Although we had hypothesised that trust and privacy might

emerge as factors, this was not the case and young Saudis did not express concerns about the privacy of their personal data. For those who were already using mobile health apps, perception of utility (PE) and the ease of use experienced led to a stated intention to continue to use the apps. Social influence was a factor for both actual and potential users, though there was no difference between familial/friends' influence and that of health care providers. The results are discussed in terms of the Hofstede model of cultural difference. Finally, the study notes its limitations and uses them to make recommendations for further research.

# Contents

# Chapter One: Introduction

This thesis, situated within the field of socio-technical studies of information technologies, describes a questionnaire-based study into the attitudes of young Saudi Arabian citizens to the use of mobile applications to prevent and treat obesity and overweight. This introductory chapter sets out the context of the thesis and explores the issues affecting the adoption and acceptance of fitness apps in Saudi. It describes the problem of obesity in KSA and briefly describes how mHealth apps might address this problem. It sets out the research aims and objectives, discusses the potential contribution to knowledge, suggests the potential significance of the reearch and gives a road map of the remaining chapters.

## 1.1. Statement of the Problem

In a recent study, DeNicola et al (2015, p. 191) note that "[o]verweight and obesity are now a global epidemic, with more than one in five people qualifying as obese worldwide. These conditions are accompanied by excessive rates of non-communicable diseases (NCDs) related to overweight, like type 2 diabetes mellitus, hypertension, and cardiovascular diseases". The World Health Organisation reported that "worldwide obesity has more than doubled since 1980. In 2014, more than 1.9 billion adults, 18 years and older, were overweight. Of these over 600 million were obese". In percentage terms, "39% of adults aged 18 years and over were overweight in 2014, and 13% were obese" (WHO, 2016).

It is not obesity itself that constitutes a public health problem but its effects on health. The Nuffield Foundation (2007, 5/1) reports that:

> There is evidence from epidemiological research that obesity is an important risk factor for a wide range of chronic diseases, including type 2 diabetes, hypertension, coronary heart disease, stroke, osteoarthritis, some cancers, respiratory dysfunction, liver dysfunction, gall-bladder diseases and metabolic syndrome.5 As with any epidemiological correlation, separating the effects on health of obesity from the associated effects of other factors such as lack of physical exercise and poor nutrition is not straightforward.6 Nevertheless, globally, being either overweight or obese has been estimated to be the

seventh most significant risk factor for mortality and the eighth most significant risk factor for disease. As an example, it has been estimated that 30,000 deaths a year in England are attributable to obesity and that deaths linked to obesity shorten life by an average of nine years.

The Middle East has been particularly heavily affected by increasing obesity. As shown in Table 1.1, amongst the 15 countries with the highest proportions of obesity are found five Middle Eastern, specifically Gulf, states: Qatar, Kuwait, United Arab Emirates, Bahrain and Saudi Arabia.

Saudi Arabia, the largest and most populous of this group of countries, is part of this trend (see Figure 1.1). The proportion of Saudis classified as obese has increased from 16.4% in 1992 to 52.9% in 2017 and is projected to rise to 59.5 in 2022.

| Rank | Country | Percentage of population |
|---|---|---|
| 1 | Palau | 47.10% |
| 2 | Nauru | 45.10% |
| 3 | Marshall Islands | 42.30% |
| 4 | Samoa | 41.60% |
| 5 | Tonga | 41.10% |
| 6 | Qatar | 41.00% |
| 7 | Kiribati | 40.10% |
| 8 | Tuvalu | 39.60% |
| 9 | Kuwait | 38.30% |
| 10 | Bahamas, The | 36.60% |
| 11 | Fiji | 35.90% |
| 12 | United States | 35.00% |
| 13 | United Arab Emirates | 34.50% |
| 14 | Bahrain | 34.10% |
| 15 | Saudi Arabia | 33.70% |

Table 1.1. Countries with Highest Levels of Obesity (World Atlas, 2017)

This regional situation is also visible in a map view (Figure 1.1).

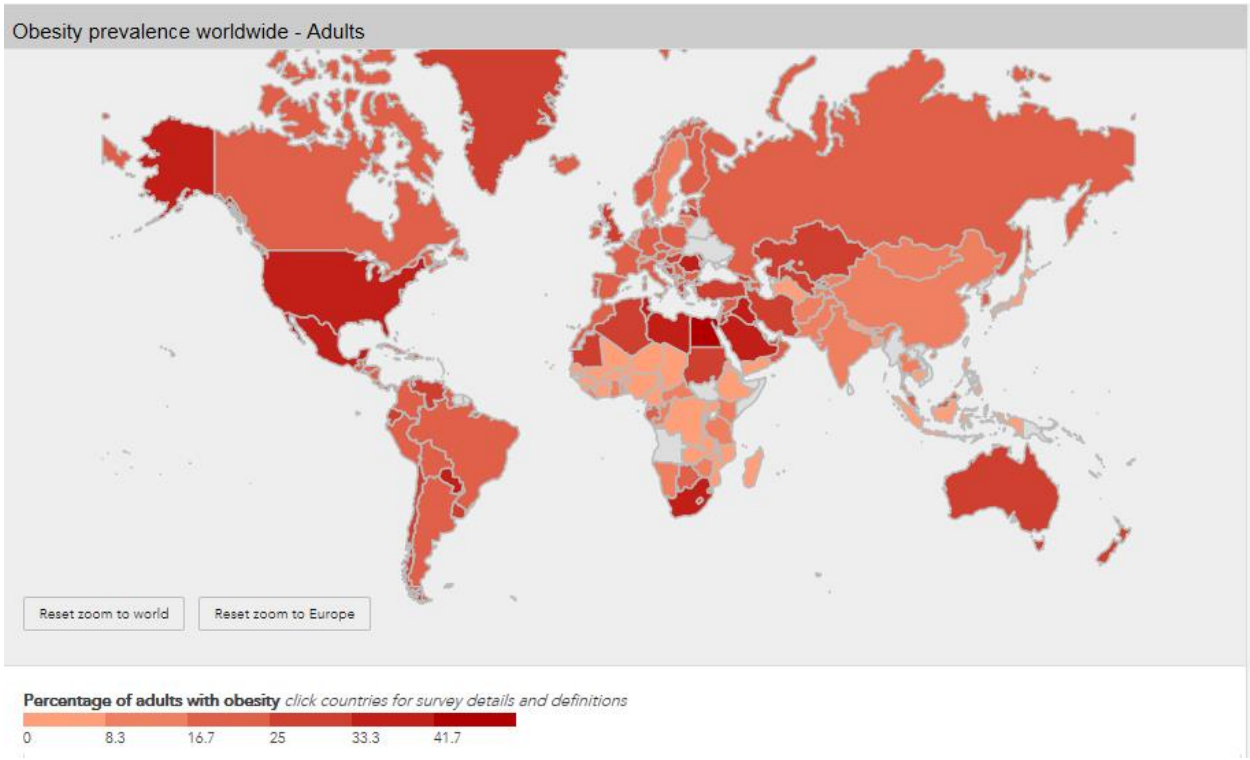



Figure 1.1 Obesity levels worldwide (http://www.worldobesity.org/data/map/overview-adults#)

| Year | Men | Women | Overall |
|---|---|---|---|
| 1992 | 12 | 20.7 | 16.4 |
| 1997 | 26.6 | 43.1 | 34.9 |
| 2002 | 29.3 | 46.3 | 37.8 |
| 2007 | 32 | 51.1 | 41.6 |
| 2012 | 35.1 | 58.7 | 46.9 |
| 2017 | 38.2 | 67.5 | 52.9 |
| 2022 | 41.4 | 77.6 | 59.5 |

Table 1.2 Historical and projected obesity prevalence (%) in KSA (Alqarni/World Atlas, 2016).

Overweight and obesity are more prevalent in Saudi women than in Saudi men. Table 1.2 shows existing trends and future projections of gender-specific and

overall obesity prevalence in KSA. According to the statistics, the overall rate of obesity is continually increasing, Saudi women have a higher obesity rate than men, which is projected to reach 77.6% by 2022 (World Atlas, 2016).

There are also regional variations, with obesity rates in rural areas much lower than in urban centres. DeNicola et al report that “66%–75% of adults and 25%–40% of children in the Arab region are either overweight or obese” and that “some of the highest prevalence rates for overweight and obesity are found in the Kingdom of Saudi Arabia (KSA). For example, a recent study conducted in Riyadh showed that 82% of participants were overweight or obese” (p. 193).

As shown in Figure 1.2, the population of KSA is a relatively young one, with nearly 12 million of the total population of approximately 28,500,000 aged between 20-40 years old. It could therefore be argued that intervention amongst this sector of the population (and younger) is particularly important as it will effect a larger proportion of the population and have longer lasting effects than interventions for older people.

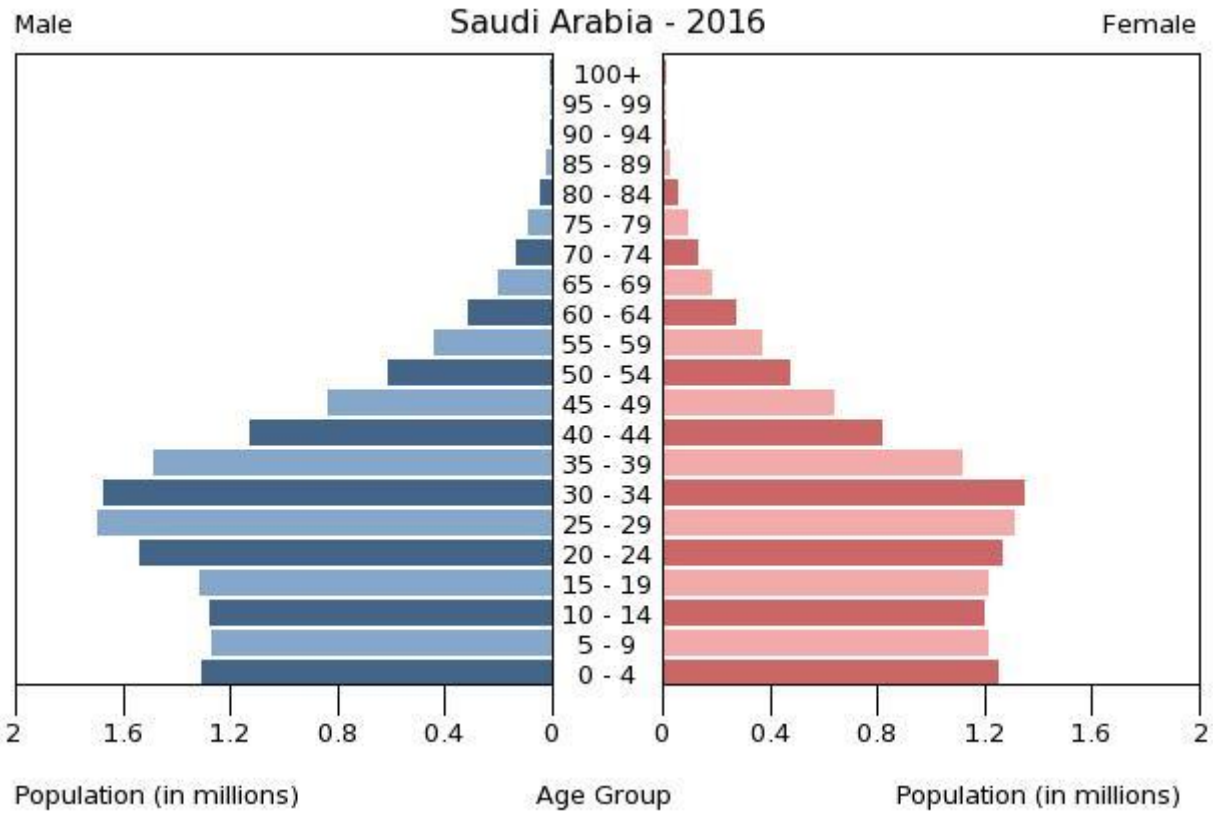



Figure 1.2 Population pyramid of Saudi Arabia 2017 (CIA, 2017)

Several explanations have been put forward for the trend to overweight and obesity in KSA. According to DeNicola et al (2015, p. 192) “[c]ompeting cultures is (sic) partly to blame, as the combination of persisting traditional Saudi cultural practices, modern cultural changes, and economic prosperity has created an obesogenic environment that promotes unhealthy eating, sedentary lifestyles, and weight gain”.

### 1.1.1 Diet

Dietary choices are a major factor. In their study of obesity amongst Saudi primary school children, Amin et al (2008) found that "[m]issing and or infrequent intake of breakfast at home, frequent consumption of fast foods, low servings of fruits, vegetables, milk and dairy product per day, with frequent consumption of sweets/candy and carbonated drinks were all predictors of obesity and overweight among the included male schoolchildren” (p. 311). AlHazzaa et al (2011) studied the eating habits of Saudi adolescents and discovered again that fruit, milk, vegetables and a meal at breakfast time were absent from their diet, while both male and female respondents reported high intakes of “French fries and potato chips, cakes and donuts, and candy and chocolate” (p. 140). With a focus on older students, Al-Rethaiaa et al (2010) found that “[t]he most common eating habits encountered were eating with family, having two meals per day including breakfast, together with frequent snacks and fried food consumption. Vegetables and fruits, except dates, were not frequently consumed by most students” (p. 39). Dietary choices would therefore be one important area to target for behaviour change in any attempt to tackle the obesity crisis.

DeNicola et al (2015) identify the economic changes in food systems that have contributed to these choices being available, as fast food chains and even online food delivery have penetrated Saudi cities: “data collected by a smartphone application used in the KSA to find local businesses showed that of the more than 1 million Saudi consumers that use the application each month, the most frequent search keyword used by a wide margin is “restaurants,” followed by “sweets,” “pizza,” and “Burger King” Seventy-seven per cent of users also search for food places that offer delivery, reflecting the preference of many Saudis to dine at home in front of the television” (p. 193). The authors

comment that “although food may be plentiful and affordable in the KSA, the quality of much of it is poor. Traditional Saudi food was high in fibre and low in unhealthy fats and sugars, but now Saudis are consuming more foods that contain harmful fats, polyunsaturated fats, sugar, salt, and white flour…” (p. 193). In an exploration of the psychological and social factors that prevented adults in a Saudi hospital from following a healthy diet, AlQuaiz and Tayel (2009) identify lack of will power, and, interestingly for this study, since the nature of social influence is one of the constructs explored in the study’s theoretical model, adverse social influence:

> In the present study, barriers to a healthy diet were lack of willpower, followed by lack of social support and lack of time and resources. Lack of willpower was the commonest barrier for a healthy diet. It was also mostly reported by married and middle-aged participants. It seems that it is difficult to give up favorite foods and substitute with healthy foods, especially if the individual is living with a family… Lack of social influence was mostly reported by participants of middle age and of less than university education. It is clear that lifestyle change interventions are more effective when others close to the individuals are involved. Family, friends, neighbors and co-workers represent potential resources for maintaining lifestyle changes. Also, large numbers of social gatherings with extended families interfere with adherence to a healthy diet. Lack of time and resources were barriers for healthy diet among younger and never married individuals. Busy lifestyles and a paucity of restaurants with healthy food choices have led the younger age group to consume fast food (p. 34).

### 1.1.2 Physical activity

The other main contributing factor is the sedentary lifestyle of Saudi citizens, particularly urban dwellers, allied to a lack of physical activity. AlHazzaa et al (2011) found that their adolescent subjects spent a large proportion of their time in front of a TV screen (and that this was strongly correlated with consumption of unhealthy food):

> The prevalence of sedentary behaviors found in the present study among Saudi adolescents was remarkably high. The American Academy of Pediatrics (AAP) has expressed concern about the amount of time that children and adolescents spend viewing TV and has issued guidelines recommending that screen time not exceed 2 hours per day… Only 16% of adolescent males and less than 11% of females in the present study actually met the AAP recommendations on daily screen time. The implication of this finding is that there is a need to reduce the time spent by adolescents on TV viewing and computer use (p. 143).

AlHazzaa et al (2011) also studied physical activity, which they treated as a separate factor from sedentary behaviour. They found a very high "prevalence of physical inactivity, especially among Saudi females. About half of the males and less than quarter of the females met the current recommendations of 1 hour daily of moderate-intensity physical activity" (p. 144). DeNicola et al. also report on this phenomenon amongst Saudi adults, finding that In addition to poor eating styles, "physical inactivity is rampant in the Saudi population. Nearly 70% of the total Saudi population does not perform an adequate amount of physical activity, and physical inactivity is higher in Saudi women than in Saudi men" (p. 194).

### 1.1.3 Obstacles to healthy eating

There are many reasons for both poor eating choices and physical inactivity, which will be important for the current study. DeNicola et al present some of these reasons in terms of "competing cultures," focussing on the incompatibility of traditional Arab culture and imported Western habits. In terms of diet, Ng et al (2011) explain that "social cultural norms and attitudes towards weight in some Arab countries, where rich high-fat food plays an important role in the daily diet, and where 'plumpness' is considered a sign of beauty. In addition, women tend to spend a large part of their time indoors, with limited access to active leisure time activities, while indoor activities (such as TV watching) and socializing frequently involve eating and snacking" (p.10). In addition, large social gatherings are frequent and encourage consumption of large amounts of food. One such gathering would be the traditional fast-breaking during Ramadan. This means, perhaps counter-intuitively, that weight gain after a month of daytime fasting is very common: "many families in the city of Jeddah reported weight gain (in both men and women, adults and children) after the month of Ramadan, usually a time for improving health and losing weight in addition to its spiritual and religious purposes. During Ramadan, participating Muslims fast during sunlight, and eating and drinking only before sunrise and after sunset. When asked their perceptions about what caused their weight gain, most participants attributed it to the types and quality of food consumed during Ramadan – often fat and sugar rich – and to the excessively sedentary behaviour" (Bakhotmah, 2011, p. 72).

Additional factors affecting women in particular are aesthetic norms and clothing traditions. DeNicola explains that “[s]ome Arab cultures still hold social norms and attitudes that favor “plumpness” as a sign of beauty... In the KSA, thinness is not desired, yet obesity is frowned upon. For example, Rasheed et al (1994) found that all but one Saudi female participants who were underweight desired to increase their weight, as did some Saudi women who were of normal weight or overweight. However, most normal weight, overweight, and obese women in this study did desire to lose weight. Preference for larger body size among these women was significantly associated with lower education and greater illiteracy”. There appears to be a good deal of ambivalence around the notions of plumpness and beauty.

Clothing may also play a role: “[a]nother example of old and new culture competing in the KSA comes from the cultural requirement of Saudi women to wear the “abaya,” a loose-fitting robe that covers the body, when outside the home. The traditional abaya has become a shield against stigma for many overweight and obese Saudi women who find that being able to hide their shape under the loose clothing reduces both their bodily and social discomfort. Some Saudi women believe that this loose clothing lends itself to further weight gain because it is less restricting than other clothes (i.e. jeans, fitted dresses), and an already overweight woman may not notice the addition of additional pounds (Alqout & Reynolds, 2014, p. 670).

### 1.1.4 Obstacles to physical inactivity

As far as physical inactivity is concerned, a major contributing factor for all ages and genders is the very high outdoor temperature, which makes outdoor activity such as jogging or team games extremely uncomfortable. Public transport is sparse, meaning that few Saudis walk to train stations or bus stops, but use private cars. For younger Saudis, “major factors that contribute to youth inactivity in Saudi Arabia include a reliance on cars rather than walking for short-distance travel, including trips to and from school and limited quality physical education programs in schools, especially for girls” (AlHazzaa et al, 2011). The influence of the physical environment has been recognised by the Nuffield Council as a major contributor to obesity: they use the term “obesogenic” to describe environments that make it more “difficult for people to

lead an active life, and (where) foods are increasingly accessible, affordable and energy-dense. Modifying the design of urban environments and buildings is one way of making it easier for people to increase their activity levels. This could include segregating walking and cycling routes from heavy traffic, and maintaining more public parks and children's playgrounds" (Nuffield, 2007, Ch. 5). This is clearly a major factor in KSA.

In addition, for cultural reasons, families may not encourage females to take part in physical activity (Khalaf, 2013). Saudi women spend a large amount of their time indoors, as cultural and social pressures oblige them when outside the home to be accompanied by a male relative (called a guardian), who may not be easily available (Ng et al, 2011). Saudi women are not widely permitted to drive for religious and cultural reasons and so drivers are employed by families to drive female members of the household when a male relative is not available. AlHazzaa's analysis found "a direct association between having a domestic driver and obesity in rural females and in both urban and rural males. The availability of a driver means that many people have become dependent on cars for commuting. In fact, Saudi adolescents have been found to prefer taking a car rather than walking even for a short distance… a pattern of behaviour which can decrease daily physical activity" (ibid).

Access to physical activity is extremely limited for Saudi women in terms of accessible sporting venues, appropriate athletic attire, role models, and strongly conservative sociocultural and religious norms (Ng et al, 2011). Not many female schools in Saudi Arabia offer physical education classes. In addition, particularly in urban areas, easy access to digital media and to television were found to lead to sedentary habits (AlHazzaa et al, 2011). One scholar goes so far as to suggest that "high incidence of female obesity can be attributed to government policy…This ban on women's sports and active lifestyle is the most devastating of any other restriction, because it impacts their health directly, which impacts everything else—their education, family lives, and mental health" (AlAhmad & Mohamud, 2016)

Overweight and obesity clearly constitute a particular and growing problem in Saudi Arabia, with serious implications for the health of the nation both currently

and in the future. The poor dietary choices and physical inactivity leading to the current situation have their roots in a large number of geographical, economic, social and cultural factors, as briefly examined above. As is made clear in the Nuffield Foundation's UK-based report, "[t]he causes of obesity are complex, and there are no simple solutions". However, partial solutions may be available. The aim of this research study will be to gauge Saudi attitudes towards the potential of mobile applications as a (partial) solution to this serious problem.

## 1.2. MHealth as a potential solution

As discussed in Section 1.1, there are serious obstacles in Saudi Arabia to both healthy dietary choices and physical exercise. Mobile phones are becoming an increasingly important platform for the delivery of health interventions, making mobile phone applications promising tools for contributing to preventing and treating overweight and obesity. In recent years, mobile phones have been used as tools for encouraging physical activity and healthy diets, for symptom monitoring in asthma and heart disease, for sending patients reminders about upcoming appointments, for supporting smoking cessation, and for a range of other health problems (Blake, 2008). In fact, just as Tripp et al (2013) made the bold claim regarding maternity care that "[t]he smartphone is rapidly and surreptitiously transforming maternity care leaving policy makers and health care professionals behind" we could make a similar claim for mobile health applications in general.

Mobile technology has significant potential to help revolutionise personal wellness and the delivery of healthcare. Mobile phones, wearable sensors, and home-based telemedicine devices can help caregivers and individuals themselves better monitor and manage their health. This can happen not only in formal healthcare settings such as hospitals and clinics, but also as an individual's own activity, which is the focus of this study. Studies now suggest that mobile applications such as fitness apps can be an effective tool to prevent obesity (Payne et al, 2015) and can help to change health-related behaviour (Conroy et al, 2014; Zhao et al, 2016).

The technology take-up to allow such an innovation is evident in KSA. Many of the country's 18 million citizens carry multiple smartphones, as evident from

Table 1.3, where the number of smartphone users is more than the total population:

| Rank | Country | Total Population | Smartphone Penetration | Smartphone Users |
|---|---|---|---|---|
| 1 | United Arab Emirates | 9,398,000 | 80.6% | 7,573,000 |
| 2 | Sweden | 9,921,000 | 72.2% | 7,167,000 |
| 3 | Switzerland | 8,454,000 | 71.7% | 6,061,000 |
| 4 | South Korea | 50,705,000 | 71.5% | 36,262,000 |
| 5 | Taiwan | 23,564,000 | 70.4% | 16,596,000 |
| 6 | Canada | 36,626,000 | 69.8% | 25,556,000 |
| 7 | United States | 326,474,000 | 69.3% | 226,289,000 |
| 8 | Netherlands | 17,033,000 | 68.8% | 11,720,000 |
| 9 | Germany | 80,636,000 | 68.8% | 55,492,000 |
| 10 | United Kingdom | 65,511,000 | 68.6% | 44,953,000 |
| 11 | Australia | 24,642,000 | 67.7% | 16,671,000 |
| 12 | Belgium | 11,444,000 | 67.3% | 7,706,000 |
| 13 | Spain | 46,070,000 | 66.8% | 30,771,000 |
| 14 | Azerbaijan | 9,974,000 | 66.4% | 6,619,000 |
| 15 | Italy | 59,798,000 | 65.8% | 39,323,000 |
| 16 | France | 64,939,000 | 65.3% | 42,399,000 |
| 17 | Saudi Arabia | 32,743,000 | 65.2% | 21,337,000 |
| 18 | Portugal | 10,265,000 | 65.0% | 6,672,000 |
| 19 | Czech Republic | 10,555,000 | 64.8% | 6,835,000 |
| 20 | Malaysia | 31,164,000 | 64.1% | 19,967,000 |

Table 1.3 List of countries by mobile penetration 2017 (Newzoo, 2017)

Mobile phone market penetration is an excellent measure of technology uptake in different regions such as Saudi Arabia with high rate of growth. (Al-Shehri, 2013) concluded that “the young population in Saudi Arabia are the biggest users of mobile social media in the Arab World”. The use of mobile apps is now popular and may help to obtain reliable information as well as making it easier to share and analyse data. A report by the New York Times in (2015) describes life for young Saudis as “an ecosystem of apps” (Hubbard, 2015), as “confronted with an austere version of Islam and strict social codes that place sharp restrictions on public life, young Saudis are increasingly relying on social media to express and entertain themselves, earn money and meet friends and potential mates”.

> Lacking free speech, they debate on Twitter. Since they cannot flirt at the mall, they do it on WhatsApp and Snapchat. Young women who cannot find jobs sell food or jewellery through Instagram. Since they are banned from driving, they get rides from car services like Uber and Careem. And in a country where shops close for five daily Muslim prayers, there are apps that issue a call to prayer from your pocket and calculate whether you can reach, say, the nearest Dunkin' Donuts before it shuts (Hubbard, 2015).

Looking to the cost of healthcare, governments discuss what the public health spend in the healthcare sector should be and what standards of health care should be targeted. To overcome these obstacles around cost, access, and standards, healthcare systems must be highly innovative and inventive in their approach to delivering services. One way is to leverage the experience of other sectors that have used technology to improve their processes. For example, financial services and telecommunications have been using technology intensively and investing significantly in IT development and IT enabled innovations.

Creative use of new mobile applications, wearable health information and sensing technologies (mHealth) has the potential to reduce the cost of health care and improve well-being in numerous ways (Kumar et al, 2013). With the introduction of mHealth technologies, people who receive healthcare are no longer simply patients, but have become consumers who need to be in charge and aware of their health. This is increasingly visible in the West, in the uptake of wearable fitness apps and fitness-related social networking movements, a trend known as "the Quantified Self" (Swan, 2009, 2012), which uses sensors and user input in mobile and other wearable apps to obtain and manipulate data about an individual's activity with the aim of improving self-awareness and ultimately physical and mental health. Typical apps might count the number of steps taken each day, monitor sleeping patterns, track heart rate, measure calories consumed and so on. According to Swan,

> [q]uantified self-tracking is the regular collection of any data that can be measured about the self, such as biological, physical, behavioral or environmental information. Additional aspects may include the graphical display of the data and a feedback loop of introspection and self-experimentation. Health aspects that are not obviously quantitative such as mood can be recorded with qualitative words that can be stored as text or in a tag cloud, mapped to a quantitative scale, or ranked relative to other measures such as

> yesterday's rating. Many health self-trackers are recording measurements daily or even more frequently (blood pressure for example) (Swan, 2009, p. 515).

While some of the software and hardware devices use in tracking are still expensive one-off solutions, such as implanted cardiac monitors, there has recently been a strong trend towards consumer level devices, many based on wearable bracelets or smart watches, which gather both unautomated input (e.g. a user types in food they have consumed) and automated data collection, e.g. steps taken. The basic technology used here is "accelerometer-detected energy expenditure or calories burned. A second feature provided by some devices is sleep measurement. Most devices are wearable for about a week between battery recharges and require connecting to a computer, usually via USB, to upload the data" (Swan, 2012, p. 516). As Swan points out, such devices are not to be seen as gimmicks, but as drivers of to what may be a major shift in perceptions of healthcare, i.e. no longer a centralised health service model but "patient-driven health care models, particularly health social networks, consumer personalized medicine and quantified self-tracking. These models support an early shift to patient-driven health care as individuals are starting to measure, track, experiment, intervene, treat and research their conditions and symptoms, genomes, biomarkers, behavior and environment, both individually and in collaboration with others" (Swan, p. 520). In some sense, then, an individual who adopts this type of technology may also be accepting a very deep change in the current model of healthcare in the country in question.

Despite the positive potential of mHealth apps, they face the possibility of non-take-up in the Saudi context. There are several reasons that cause the slow user adoption of mHealth apps in any country: the wide range of available health apps in the market and the lack of data security. It is difficult for the user to make a choice between good and bad health apps based on their quality. In addition, consumers are worried about their data privacy. While the potential benefits of this "mHealth" technology include better health, more effective healthcare and reduced cost for governments, this technology also poses significant security and privacy challenges (Carter et al, 2015). Other possible

barriers that may apply in KSA, many already mentioned in Section 1.1, are listed below:

- conservative forces such as religion and family
- low mobile penetration in rural areas
- cultural issues with regard to gender
- conditions for exercise – climate, access to health clubs
- body image issues
- diet perception

A higher-level issue is the match of the mHealth solution with the cultural specificity of the context. While in the West, the idea that a person's general health is, largely, his/her personal responsibility, other cultural factors may be at work in Saudi Arabia. One is a reliance on the state to provide: oil wealth means that "Gulf nationals typically do not pay income tax, have free health care and education provided by the state, receive subsidies for electricity and fuel, and often receive other benefits (such as land grants). Traditionally they have also expected the state to provide a job - an idea enshrined in some Gulf constitutions – and, often, housing" (Kinninmont, 2015). Another influence tending towards a more passive approach to personal health may be the interpretation of Islam teachings. Klautzer et al (2014) point out that "while the Quran encourages physical activities to take care of the body, the misinterpretation of the belief that "illness and wellness are God's will" may lead to fatalism with respect to health conditions. Some regional health authorities have tried to engage the respective religious authorities, but even explicit support of healthy conduct does not guarantee the desired individual behaviour. For example, in spite of a *fatwa* (a religious decree) exempting people with diabetes from fasting during Ramadan about 81% of patients with type 1 diabetes and 94% of patients with type 2 diabetes were fasting at least 15 days during Ramadan, according to a multi-country study of 3,394 diabetics in 13 countries including the UAE and Saudi Arabia" (p. 112).

There may be a link here to the general cultural make-up of the country. In his comparative study of the cultural dimensions typifying countries around the

world, Gert Hofstede found that Saudi Arabia had an extremely low tendency to individualism:

> The high side of this dimension, called individualism, can be defined as a preference for a loosely-knit social framework in which individuals are expected to take care of only themselves and their immediate families. Its opposite, collectivism, represents a preference for a tightly-knit framework in society in which individuals can expect their relatives or members of a particular in-group to look after them in exchange for unquestioning loyalty. A society's position on this dimension is reflected in whether people's self-image is defined in terms of "I" or "we." (Hofstede, 2017.)

Thus an individual in Saudi Arabia, with its individualism score of 25 (of 100), might feel less personal responsibility towards his/her health than in a more individualist country such as the UK (89) or the US (91). As a result of cultural factors such as these, the health app providers may face unexpected problems of meeting the end-user needs.

The question is now what drives consumers' initial usage intention concerning health-related Smartphone apps and what factors influence their continuing usage intention, since there is normally a decrease in interest following the adoption of any innovation. This study aims to discover what affects both Saudi citizens' initial decision to use (or not use) fitness apps and also their decision to continue or discontinue their use.

## 1.3. General Research Design

There are clearly a number of interesting themes to be addressed around the topic of obesity and Saudi Arabia. While research with a sociological or public health interest might address the causes of the problem, and the obstacles to its solution, in terms of the issues briefly discussed above, an IT-oriented approach will focus on the place of technology in this picture. Within the IT perspective, rather than the functionality or interaction issues involved, this study focuses on the prospects for potential users to recognise the capability of mobile health apps to help improve their health and to explore the reasoning of these potential uses in their decisions over acquiring and using apps of this type.

This type of research is generally known as "technology acceptance". A large number of information systems researchers have investigated and developed

models to predict user acceptance and adoption of technology, first in business settings and more recently in more individual, consumer contexts. . Among the various models that researchers have applied to predict and explain users' acceptance behaviour are the technology acceptance model (TAM) (Davis et al., 1989), the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al, 2003) and the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) (Venkatesh et al, 2012), which relates specifically to acceptance and use of technology in a consumer context, which may differ from acceptance of IT in institutional settings as in Davis' work. The models are discussed and evaluated in more detail in Chapter Two. This study conducts an empirical survey based on UTAUT 2 to explore the issues involved in acceptance and adoption of fitness apps in the KSA and potentially in countries with similar characteristics.

## 1.4. Research Aims and Objectives

### 1.4.1. Aim

The aim of this research study is to determine the factors that affect user acceptance and adoption of mHealth applications to support the health needs of overweight and obese people in Saudi Arabia, or those trying to maintain a healthy weight.

### 1.4.2. Research Objectives

This will entail a number of concrete objectives, as follows:

1. Review previous work in adoption of innovation, public health, EHealth, and mHealth.
2. Identify culture, social, economic and technological aspects of KSA relevant to mHealth.
3. Explore theoretical models of the adoption and acceptance of mHealth that deal with consumers and select the most appropriate.
4. Consider modifying the model selected in 3) with factors identified in 1) and 2).
5. Design research instruments based on the research model.
6. Carry out data collection.

7. Explore findings in context of the UTAUT2 model.

## 1.5. Anticipated Original Contribution to Knowledge

The significance of the research lies in its contribution to our understanding of the prospects for mHealth in Saudi Arabia and also to the fit of the UTAUT2 model to this context. The results should reveal the drivers of adoption of mobile health applications, and, crucially, the perceived obstacles that would need to be overcome by public health organisations and/or by commercial mHealth operators, in order to encourage mHealth take-up.

The findings of this research will add to the body of knowledge on mHealth adoption and acceptance for non-Western cultural settings, specifically Saudi Arabia and countries with similar characteristics, and will be valuable to health-care providers and technology suppliers in understanding the needs of end-users of mobile health technologies. It aims to explore whether the assumptions about mobile health app design and functionality made based on knowledge of Western users can safely be used in a non-Western setting.

It will also contribute in testing the applicability of the theoretical framework of acceptance for new technology in Saudi context, i.e. testing the UTAUT2 (Venkatesh et al, 2012) in the context of mHealth acceptance (i.e. fitness apps), specifically in the context of a developing country (i.e. Saudi Arabia).

## 1.6. Synopsis of the thesis

1. **Introduction**: introducing the research, its context, aims and methodology.
2. **Literature review:** reviews the existing research literature in the relevant fields:
    - Public health, which discusses public health in general, in the West, Middle East and Saudi Arabia, looking at obesity from a public health prospective.
    - EHealth – development of EHealth systems in general, the West, Middle East and Saudi Arabia. How EHealth may be considered a tool to help countering the obesity problem.

- mHealth - development of mHealth systems in general, the West, Middle East and Saudi Arabia. How mHealth apps may help to counter obesity, in particular fitness apps.
- Studies about acceptance of mobile health applications in an obesity context.
- Technology Acceptance models, including TAM, UTAUT and UTAUT2. UTAUT2 have been selected as a framework for this project.
- IT and Health related behaviour: other factors that affect intention to use mHealth applications and continuance usage of mobile health applications
- Cross cultural models and the relevance of cross-cultural issues in technology acceptance

3. **Research Design:** discusses theoretical models for research, the assumptions for these models and various measurement methods and their analyses. This chapter presents the data gathering instruments and the role of the pilot study and focus groups in shaping the research questions. It also includes discussions of the sample,
4. **Research Methods in Practice:** Describes how the methods described in the previous chapter were applied.
5. **Results and Analysis:** presents the results of the studies
6. **Discussion:** a discussion of the results in relation to the hypotheses, also discussing how the findings relate to other similar studies.
7. **Conclusions:** Summary of results, plus contributions and limitations of the research, identifying directions for further research.

# Chapter Two: Literature Review

## Introduction

In this chapter, we review the literature on areas and disciplines that contribute to the research reported in the thesis. These are:

- Public Health
- E-health
- MHealth
- Technology acceptance approaches
- Obesity-related attitudes and behaviours, particularly in KSA
- Cross cultural models

## 2.1. Public Health

### 2.1.1. Public Health in the Developed World

Public health is an extremely broad topic, but is the framework within which thinking on mHealth approaches to obesity has often taken place, especially when practical measures to apply mHealth solutions are part of the discussion. In this section, we will very briefly cover definitions of public health and review some public health initiatives in the West, the Middle East and Saudi Arabia, in order to give a high-level overview of public health and how it is different, in terms of culture and social aspects, from nation to nation.

There are several definitions of public health, including the following:

> The science and art of preventing disease, prolonging life and promoting health through organised efforts of society" (Acheson, 1988; WHO).

The Faculty of Public Health of the Royal Colleges of Physicians of the United Kingdom stated that "[t]he mission of public health is to 'fulfil society's interest in assuring conditions in which people can be healthy" that means everything related to health and to be healthy physically or physiology. The US-based Center for Disease Control (CDC) stated that "Public Health is the science of protecting and improving the health of communities through education, promotion of healthy lifestyles, and research for disease and injury prevention" (CDC, 2001). A final definition comes from the Nuffield Council on Bioethics,

which defines public health as “[t]he science and the art of preventing disease, prolonging life, and (organized community efforts for the sanitation of the environment, the control of communicable infections, the education of the individual in personal hygiene, the organization of medical and nursing services for the early diagnosis and preventive treatment of disease, and the development of the social machinery to ensure everyone a standard of living adequate for the maintenance of health, so organizing these benefits as to enable every citizen to realize his birthright of health and longevity” (Nuffield Council on Bioethics 2007). While early public health efforts were targeted at the reduction of infection, nowadays the remit of public health organisations will include “healthy lifestyle” interventions as well. Examples of public health measures cited in the Nuffield report include:

- providing services to help people stop smoking
- improving the safety and nutritional content of foods
- providing a clean water supply
- vaccination schemes to prevent infectious diseases
- health-and-safety schemes in the work-place
- advertising campaigns to promote healthy eating, such as the ‘5-a-day’ campaign

The report notes that some of these options for improving public health “could be seen as quite intrusive. Policy makers therefore have to decide which measures are acceptable in different circumstances.” This will include deciding which interventions should be centrally funded and which should be a matter for private health providers or for the individual.

Many of the issues discussed in the context of public health arise such as obesity- and smoking-related conditions. Implicit in the use of this term is the idea that a disease is simply a result of individuals’ choices about how to live their lives. Such a view is problematic as a person’s health is influenced by a wide range of factors, as we have seen in Chapter One. Attributing poor or good states of health simply to different ‘lifestyle choices’ (whether for specific individuals or particular social or ethnic subgroups of the population) ignores the role of several other important factors that have a substantial influence on

health. These include genetic background, social and economic living standards, the built environment, the availability of, and access to, preventative and curative health services, and the influence of commercial organizations such as the food and drink industries.

### 2.1.2. Public Health in the Middle East

Regarding the history of public health, most of the world's primitive people have practiced cleanliness and personal hygiene, often for religious reasons, including, apparently, a wish to be pure in the eyes of their gods. The Quran and Old Testament, for example, have many adjurations and prohibitions about clean and unclean living. Religion, law, and custom were inextricably interwoven. Thousands of years ago, primitive societies looked upon epidemics as divine judgments on the wickedness of humankind and the idea of natural causes gradually developed. In the 5th or 4th century BCE the first systematic attempt was made to set forth a causal relationship between human diseases and the environment in the book Airs, Waters, and Places, written by Hippocrates (Porter, 1999). At the height of the Arab-Islamic civilisation between the 8th and 12th century, scholars laid the foundation for modern medicine based on observation and reasoning (Maziak, 2006). The Middle East regions are currently undergoing both epidemiological and demographic transitions as countries of the region face the challenge of addressing health issues, while at the same time trying to complete the unfinished agenda of addressing diseases. Public Health in the Middle East serves as a means to stimulate further dialogue and policy actions on critical issues of public health importance to the region.

> At the height of the Arab-Islamic civilisation between the 8th and 12th century, scholars laid the foundation for modern medicine based on observation and reasoning. Today, the geopolitical remnants of that empire, a legacy of past conflicts and externally imposed boundaries, includes some of the poorest and richest countries in the world, whose basic health indicators generally parallel their economic status (Maziak, 2006, p. 816).

Many of these countries spend far more on defence than on health and research and development combined and are lagging behind on major indices of development: Saudi Arabia is one of these countries. Maziak also claims,

“Most countries still lack reliable, regularly updated, population based data on the major causes of morbidity and mortality. The lack of expertise in systematic collection of data is mirrored by a lack of expertise in its analysis, particularly at governmental level” (p.816). Academic research, another important component of the study of health, is neither a priority nor a necessity for career advancement in most universities in the region. Arab countries currently produce less than 0.5% of the papers that are published in the world's top 200 medical journals. (BMJ, 2006, 333:815).

### 2.1.3. Public health in the Kingdom of Saudi Arabia

The first public health department was established in Mecca in 1925 and was responsible for “sponsoring and monitoring free health care for the population and pilgrims through establishing a number of hospitals and dispensaries. While it was an important first step in providing curative health services, the national income was not sufficient to achieve major advances in health care, the majority of people continued to depend on traditional medicine and the incidence of epidemic diseases remained high among the population and pilgrims” (AlMalki et al, 2011, p 785). The Ministry of Health was founded in 1950 and a number of health policies have been put into action since that time. The health of the Saudi population has been greatly enhanced in recent years. Ahmed et al, 2012 report that “an estimated population of 26 million residents with an annual growth rate of 2.2%; the Saudi Arabian healthcare sector caters to a rapidly growing population and the concurrent increasing demand on the healthcare sector” (Ahmed et al, 2012).

The health care of Saudi residents is managed by the government through the Ministry of Health (MOH). That means the health care in general is provided by government. Saudi Arabia is technically a welfare state. There is a three level system of health care system: primary, secondary and tertiary, corresponding respectively, to health centres, general hospitals and specialist hospitals. Three health sectors are considered in this review: the Ministry of Health, other entities in the government sector and the private (for profit) health sector.

The Ministry of Health is responsible for running the country’s health system. It has a well-defined, decentralized organizational and administrative structure. Its

functions include strategic planning, formulating specific health policies, supervising all health service delivery programmes, as well as monitoring and controlling all other health-related activities.

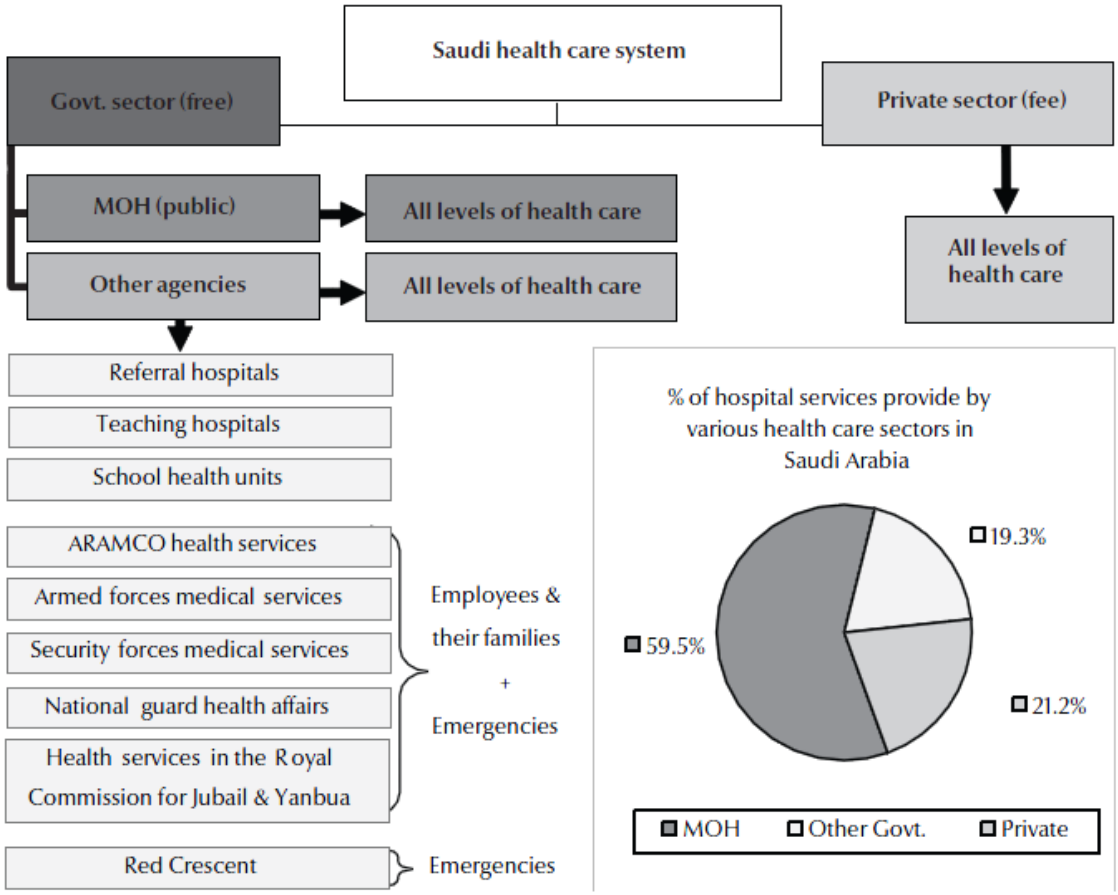



Figure 2.1 Organization of the health system in Saudi Arabia (AlMarzi, 2011)

The Ministry provides a total of "244 hospitals (33 277 beds) and 2037 primary health care (PHC) Centres. These services comprise 60% of the total health services in Saudi Arabia (AlMarzi, 2011). Other provision is made via care directed at certain professions or sectors of society, such as the armed forces. The past thirty years have seen a shift from a mainly curative approach to one that foregrounds prevention. This strategy is delivered via a network of PHCs, which concentrate on eight elements:

- educating the population concerning prevailing health problems and the methods of preventing and controlling them;
- provision of adequate supply of safe water and basic sanitation;
- promotion of food supply and proper nutrition;
- provision of comprehensive maternal and child health care;

- immunization of children against major communicable diseases;
- prevention and control of locally endemic diseases;
- appropriate treatment of common diseases and injuries; and
- provision of essential drugs (Al Yousuf et al, 2002)

A particular challenge for the Saudi Health Service is the pilgrimage or hajj, when over two million pilgrims from a wide range of countries visit the country's holy sites, particularly Mecca and Medina. Hosting such an event annually "requires a planned and organized effort across numerous agencies and departments to ensure adequate essential services, such as housing, transport, safety and health care" (AlMarzi, 2011). Preventive care for pilgrims includes "health education programmes, vaccination and chemoprophylaxis for all pilgrims via quarantine services at airports and land ports. The provision of emergency and curative services takes place through a network of health care facilities. For example, in 2009, there were 21 hospitals, of which seven were seasonal, with a total of 3408 beds and 176 beds for emergency admissions (ibid)". While many steps have been taken to improve health care provision in KSA, it is accepted that a number of challenges remain. These relate to the health workforce, privatisation, accessibility and information provision. For some of these challenges, EHealth solutions have been advocated as partial solutions.

This brief overview has suggested a number of interesting research questions that touch on the topic of MHealth for obesity:

- Potential tension between public health initiatives and the individual's decisions in this area
- Relation of health practices to Islamic traditions
- The range of potential influences on health-related behaviour

## 2.2. EHealth

The development, adoption, and implementation of a broad range of new EHealth applications, such as "ubiquitous health information websites, online social support networks, interactive electronic health records, health decision support systems, tailored health education programs, health care system web portals, mobile health communication devices, and advanced teleHealth

applications", promise to increase consumer and provider access to relevant health information, enhance the quality of care, increase efficiency, reduce health care errors, increase collaboration, and encourage the adoption of healthy behaviours (Kreps & Neuhauser, 2010). Health services across the world have recently looked to electronic health strategies to help improve services and solve problems. EHealth can be described as "an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology"(Eysenbach, 2001). This is a rather business-oriented definition. A more general definition is used by the WHO, which sees EHealth as "the use of information and communication technologies (ICT) for health" and more specifically "the cost-effective and secure use of ICT in support of health and health-related fields, including health-care services, health surveillance, health literature, and health education, knowledge and research" (2016, p. 5). It holds out the promise of improving equity, efficiency and quality of healthcare (see Figure 2.2).

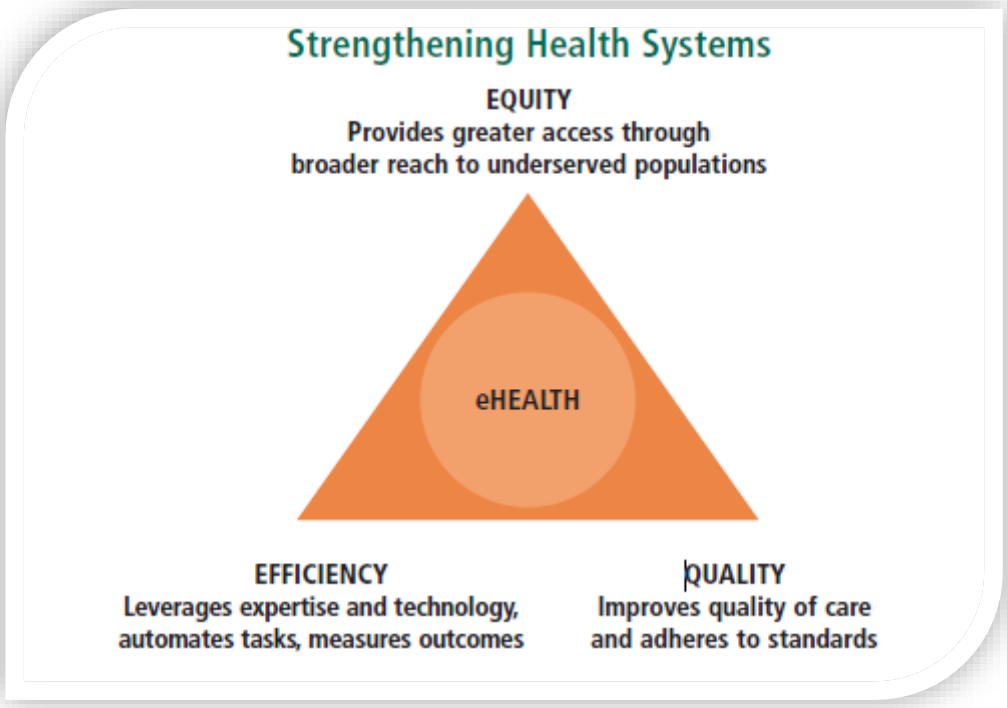



Figure 2.2 WHO 2016

Electronic patient records are a key element in EHealth, as is electronic information provision. Another focus is universal access, where “EHealth plays a vital role in promoting universal health coverage in a variety of ways. For instance, it helps provide services to remote populations and underserved communities through teleHealth or mHealth. It facilitates the training of the health workforce through the use of eLearning, and makes education more widely accessible especially for those who are isolated. It enhances diagnosis and treatment by providing accurate and timely patient information through electronic health records. And through the strategic use of ICT, it improves the operations and financial efficiency of health care systems” (WHO, 2016). Using online resources in EHealth can help to raise the level of health education with patients and can help doctors to keep up to date with the health field. In the past, the geographical distance was a problem in information provision, with Western-based information unavailable: now Ehealth services enables non-Westerners to obtain health information and possibly services at a distance. EHealth holds out the promise of greater equity in healthcare provision, as the same services will be provided to both poor and rich people as well as there is

no differences between the services that can be provided to the rural vs. urban populations, young vs. old, male vs. female people, and between neglected/rare vs. common diseases (Eysenbach, 2001). EHealth is a promising channel within which to promote obesity prevention behaviours to the young (Thompson et al, 2006; Baranowski et al, 2003).

### 2.2.1. EHealth in the Developed World

The findings from the Global Observatory for EHealth (GOe) 2015 survey show that supporting the development and delivery of health systems with good information systems is now becoming mainstream (WHO, 2016). All 194 WHO Member States were surveyed to determine whether they had national policies in place related to EHealth. Results from the 125 responses show that having an EHealth strategy is now becoming the norm; well over half of countries now report having an EHealth strategy in place and an even higher proportion of countries reported having a health information system policy.

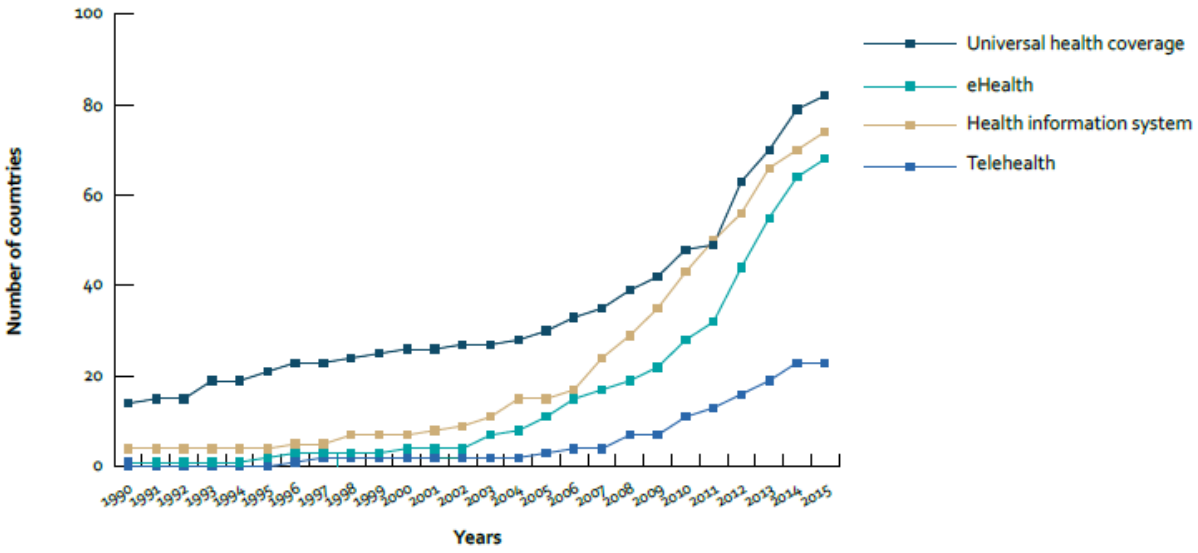



Figure 2.3 Number of countries with UHC, EHealth, HIS, and teleHealth policies or strategies, cumulatively by year of adoption (1990–2015) (WHO, 2016)

EHealth can be seen as part a nation's formal healthcare system or as a tool for individuals to take a more active part in the healthcare. From the first perspective, US and European citizens are increasingly being offered Internet health services. This could take the form of a wide range of services from

simple GP websites to tele-consultations.

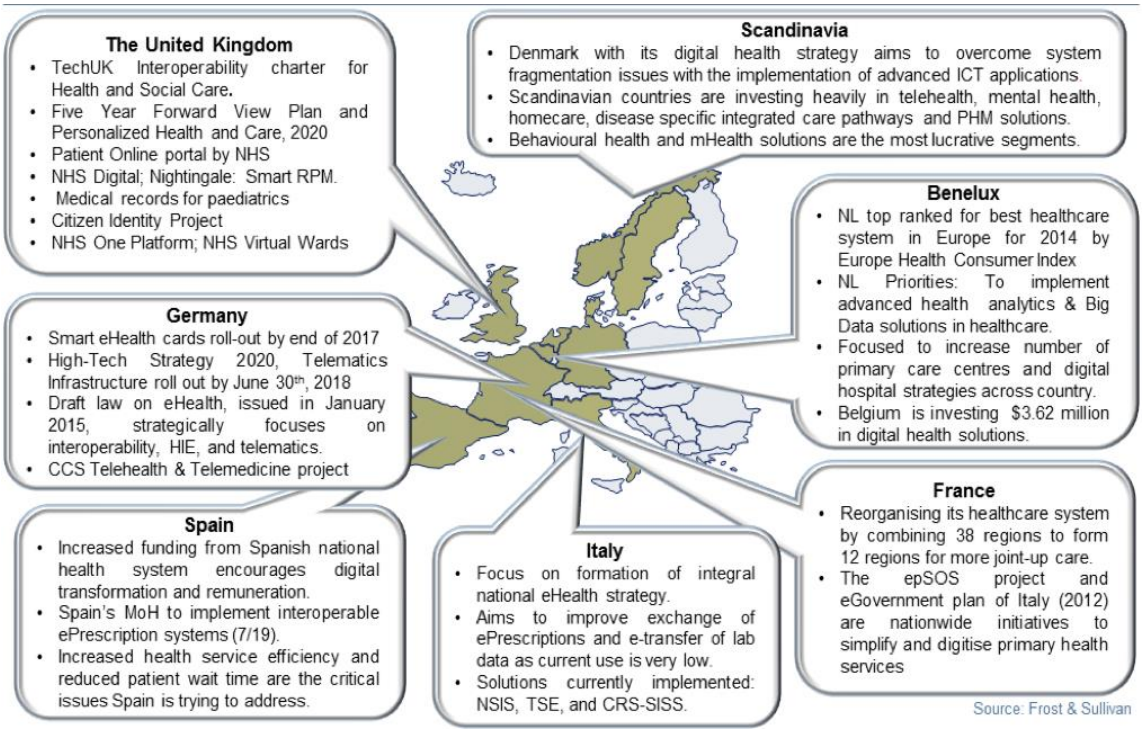



Figure 2.4 EHealth activity in Western Europe (Frost & Sullivan, 2016)

Figure 2.4 sets out some of the main practical advances in EHealth across Europe in the last five years.

From the second perspective, "[r]ecent years have seen a proliferation of health information and self-help communication on the Internet. A patient with a deeper understanding of the illness and support from others may better cope with the illness, and experience less psycho- logical distress "(Ruland et al, 2013). As Koch (2012), puts it: "Patients have moved away from being passive recipients of care. They require access to their own health data, shared decision-making and control over their care pathways. EHealth offers the tools to meet these requirements and to support both patients and care providers." Increasing ease of access to online medical information, as well as the rise of social media self-help groups for those suffering from particular conditions, have become widely accepted. In a recent study from the US, the Pew Internet & American Life Project reported that 80 per cent of Internet users, or about 93 million Americans, have searched for a health-related topic online. "The Pew researchers asked participants if they had used the Internet to search for at least one of 16 major health topics online, ranging from mental health,

immunizations to sexual health information. Most frequently, people went online to look up information about a specific disease or medical problem (63 per cent) or a particular medical treatment or procedure (47 per cent). They were also interested in diet, nutrition and vitamins (44 per cent) and exercise or fitness information (36 per cent). Other popular health topics include: prescription or over-the-counter drugs (34 per cent); alternative treatments (28 per cent); health insurance (25 per cent); depression, anxiety or stress (21 per cent) and a particular doctor or hospital (21 per cent)" (Pew, 2013). Although there are concerns about the quality and usability of such information, its use is undeniably a phenomenon to be factored in to any account of EHealth.

### 2.2.2. EHealth in Saudi Arabia

EHealth is recognised as an important aspiration for Saudi Arabia and in 2008 a budget of SR 4 billion (US$ 1.1 billion) was allocated by the MOH to run a 4-year development programme (2008–11) (AlMalki et al, 2011). A recent paper from the Oxford Business Group (2017) reports on developments in EHealth strategy in Saudi Arabia, where an Ehealth initiative was launched as a part of the country's overall information technology plan. One of the main objectives is to improve ICT infrastructure and health care. The Saudi government had already started to liberate the telecommunication sector through privatisation and competition in the early 2000's (Abanumy, 2005). The Ministry of Health (MoH) launched its Ehealth strategy in 2011, aiming to deliver a "safe, efficient health system, based on care centred on the patient and supported by e-health". The strategy consists of two five-year phases, including key milestones set for the third, fifth and final years of the plan. The Ehealth vision comprises more than 70 projects, ranging from quick wins to major multi-year endeavours, such as the roll-out of automated systems at the Kingdom's 2900-odd primary health care centres. Areas of focus for the coming year will include remote monitoring of patients, automation for pharmacies and data management" (OBG, 2017). As elsewhere, interoperable electronic health records, available for doctors to view across the country via a national electronic record system, will be an important part of the strategy. "The system will be integrated with hospitals and primary health care centres, while also linking diagnostic records systems to each other. From a patient's perspective, this will make it easier to

travel and receive medical attention anywhere in the Kingdom, as doctors will have ready access to all the information they need about a patient's history. Besides helping to reduce costs, the government hopes that such a system will encourage patients to make greater use of the country's rising number of primary care centres, rather than going straight to the hospital as a first port of call. By freeing up capacity, this, in turn, should help hospitals improve their services" (OBG, 2017). Appropriate security and privacy defences are integrated into the system.

Big Data also forms an important part of the vision for the Saudi EHealth infrastructure, with EHealth records potentially generating a valuable dataset that could be used in medical and pharmacological research. "This, in turn, could boost the medical research sector in the Kingdom and aid policymakers as they seek to design future health policies for the country. Among the datasets that the MoH anticipates being able to collect and analyse in the future as a result of the Ehealth programme are admissions and demographic data for patients; reports for diagnostic tests, such as pathological and radiological examinations, radiology and other images; medication prescriptions; and records of allergies and immunisations" (OBG, 2017). Patients with chronic diseases are also planned beneficiaries of the EHealth initiative: EHealth should provide ways for such patients to communicate with distant health care centres and to monitor their own symptoms, thus reducing the need for hospitalisation. At a more mundane level, the initiative will allow individuals to access health information through multiple channels – the internet, telephone, text messages and booklets – and more easily book appointments online. This is particularly important in a country where transport for female patients is still extremely problematic. The MoH hopes that "Ehealth will make health care delivery more efficient. Hospital staff will no longer need to wait for patient scans and diagnostic tests to be processed, or to lose time on gathering patient data that has already been captured elsewhere. Under the Ehealth system, hospitals are already tweaking their X-ray systems to send images automatically to doctors' computers" (OBG, 2017). Systems for Ehealth records, picture archiving, communications, cloud computing, the health electronic surveillance network, neonatal protection, poison control and telemedicine were all launched in 2014,

and despite continuing challenges such as poor reception in mountainous areas and the phenomenon of patients sometimes holding several different health records, individual public hospitals are now being linked, with private hospitals to follow. It should be noted that much of the plan remains to be implemented and unfortunately, Saudi Arabia was one of the countries that did not respond to the 2015 WHO Global Observatory's EHealth study, making it difficult to gauge how well efforts have succeeded. Alsulame et al's 2016 review of the current literature on EHealth in KSA retrieved 31 articles, including studies investigating Electronic Health Records (EHR), Electronic Medical Records (EMR), studies investigating Computerized Provider Order Entry (CPOE) and Clinical Decision Support Systems (CDSS). They comment, "There is evidence that EHealth in Saudi Arabia is growing where many organizational and individual initiatives have implemented EHealth applications. The number of studies available about EHealth in Saudi Arabia is still low and studies are limited to a few organizations which do not necessarily represent the experience of many other healthcare organizations".

### 2.2.3. EHealth for obesity and related conditions in Saudi Arabia

Obesity is a natural application for some of the systems that have been developed. As noted above, the prevalence of obesity among young people in KSA has increased dramatically over the last several decades (Thompson et al, 2006; Troiano, Flegal, Kuczmarski, Campbell, & Johnson, 1995). Saudi Arabia the whole population has 8% of elderly people who are over 60 years old so it is considered as a youthful population (Roudi-Fahimi et al, 2007), where fighting overweight and obesity are is particularly important for the future health of the nation. A number of EHealth initiatives have attempted to tackle this problem.

As diabetes is a growing obesity-related problem in the Kingdom, it is not unexpected that this has been a focus for EHealth researchers. Alkadi and Roudsari (2013) describe the TeMaD system, developed for the Saudi National Guard Hospital in Riyadh. TeMaD attempts to improve current healthcare services for diabetic patients, and assists healthcare givers in disease management. It strengthens communication channels between patients and their healthcare givers, possibly leading to better health. The system was trialled in 2010, serving 79 diabetes patients, who were able to upload their

blood sugar level readings and communicate with hospital clinicians. The system demonstrated good clinical outcomes, and also gathered useful information about the challenges faced by diabetes patients (mostly transportation) and EHealth developers (technology resistance among older users).

Also in the area of diabetes management, Al-Rubeaan et al (2013) describe the design and implementation of a Web-based interactive diabetes registry for health care management and planning in Saudi Arabia. This is a GIS system "established with the primary goal of developing a database for diagnosed national diabetic patients living in the Kingdom of Saudi Arabia" (ibid). It is designed to monitor the effects of various treatment regimes, to help health planners with information to make informed decisions about distributing resources and also to contribute data for research. Some of the functionality of the registry is claimed to be unique, allowing live data queries, and its use is expected to grow, with all patients registered in the next few years.

In terms of patient oriented systems, Albarrak et al (2016) studied the impact of obesity-related web sites on the decision making of Saudi students, using a self-administered questionnaire. The study found that over 40% of students *always* use the internet to obtain obesity health information from various websites and 45.3% students reported, *sometimes* use internet in getting the information. These results are similar to the US-based findings of Pew internet research, which reported that 44% of patients use the internet to gather health information. Very few students are dependent on books, family members or media as other sources of information. Although the study was expressed in very general terms, it does show that individual Saudi use web sites to retrieve health-related information.

Alrajeh et al (2014) discuss a very innovative system based on a wireless body sensor network to support obese patients: this consists of a communication system integrating a WBAN, wireless personal area network (WPAN), and wireless metropolitan area network (WMAN). The WBAN deals with communication amongst sensor nodes deployed over the patient's body, while the WPAN enables the system to communicate over WBAN with a personal

computer or smart phone, while the WMAN is capable of transferring data from personal server to medical server for medical advice in case of emergency. However, this system is still in its prototype stage.

An interesting perspective is given by Househ (20120, who proposed and defined “Islamic e-health” as “[t]he application and use of information and communication technologies to monitor and support Islamic spiritual health practices with the goal of improving Muslims' spiritual, mental, and physical health status”. Househ found that most uses of EHealth for spiritual health involved self-healing: “[m]ost of the Islamic EHealth interventions that were identified were related to education and information on spiritual healing. In Islam, spiritual healing is referred to as Ruqya and is a form of supplication that is supposed to protect and heal”. Househ found detailed descriptions of “how to correctly perform Ruqya, its benefits, and some common misconceptions. Several Facebook groups on Islamic spiritual healing were found, such as the Islamic Spiritual Healing group”. Various iPad applications, such as Ayat Ruqya, also listed religious supplications and how to perform them. Apart from Ruqya, other relevant EHealth sites used by Househ’s respondents included sites offering health information about the Hajj season and also Ramadan, where diabetic patients are monitored particularly closely.

This overview of EHealth developments globally and in Saudi Arabia has pointed to some interesting areas for this research:

- Accessiblity for geographically remote groups
- Accessibility for women in KSA
- Possible technology resistance among older patients
- Extension of current use of the internet for health information
- Isalmic tradiaion translated to EHealth sites

## 2.3. MHealth

In 2014, there were 6.5 billion mobile subscribers (93% of the entire world population), with mobile phone penetration rates reaching over 70% of the population of many European and North American countries, such as Spain (83%), Canada (78%), the United Kingdom (75%), the United States (73%), and

Italy (71%) (Bardus, 2016). This ubiquity opens up the potential of mobile devices as part of the health care provision landscape. Mobile health, or mHealth, can be defined as “the use of wireless communication devices to support public health and clinical practice” (Kahn et al, 2010; Lester et al, 2011). More broadly, MHealth can be defined as “the practice of medicine or the provision of health services supported by mobile wireless technology. This includes the utilization of mobiles devices such as tablets, smartphones or purpose built systems such as home monitoring Equipment” (Wilkinson et al, 2012). MHealth is closely related to Telemedicine, which is a technology that allows physicians to provide healthcare at distance through advanced electronic communications systems (Altuwaijri, 2008). Regular care and informational support are helpful in improving disease-related health outcomes. Communication technologies can help in providing such care and support (Krishna, 2009). Taking health care services mobile has the opportunity to alter the way healthcare providers and patients interact. In 2011, MplusHealth reported that 10% of all smartphone users had a health app on their device increasing efficiency, improving the quality and the improving the ways of access are the main goals behind mHealth. Figure 2.5 from CSM`s 2010 report "mHealth: Taking the Pulse" shows the wide range of the mHealth vision, suggesting benefits and services ranging from the availability of care at home to instant ubiquitous access to health information.


Figure 2.5. mHealth vision CSM 2010

Mobile phones are becoming an increasingly important platform for the delivery of health interventions. Mobile phones can be considered promising tools to improve the quality of life for over-weight people. In recent years, mobile phones have been used as tools for encouraging physical activity and healthy diets, for symptom monitoring in asthma and heart disease, for sending patients reminders about upcoming appointments, for supporting smoking cessation, and for a range of other health problems (Blake, 2008). Mobile technology has significant potential to help revolutionize personal wellness and the delivery of healthcare. Mobile phones, wearable sensors, and home-based telemedicine devices can help caregivers and individuals themselves better monitor and manage their health (Sorberet al, 2012). While the potential benefits of this "mHealth" technology include better health, more effective healthcare, and reduced cost, this technology also poses significant security and privacy challenges (Carter et al, 2015). Laakko et al's 2008 model of a technology framework is shown in Figure 2.6 and still applies, showing teleconsultation, chronic disease management and wellness apps as the major application types likely to thrive in this area.

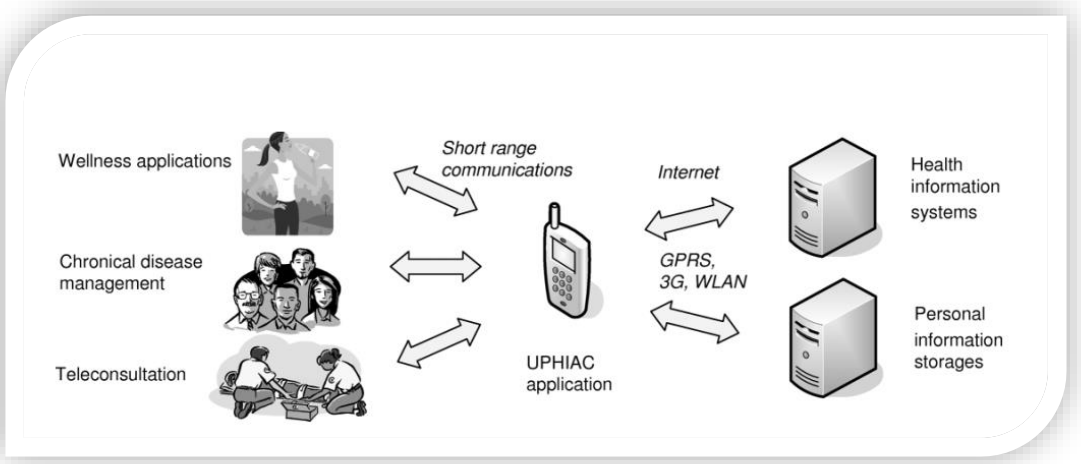



Figure 2.6 Framework for mHealth systems Mobile platform providing connectivity between distributed measurement devices and information systems (Laakko, 2008)

As the field has developed over the last decade, it now becomes possible to point to more defined examples of types of application, as opposed to Laakko's three genres. The WHO's international governmental survey on eHealth (WHO, 2016c), for instance, specifies the following major types of mHealth service:

- Communication between individuals and health services
- Communication between health services and individuals
- Consultation between health professionals
- Intersectoral communication in emergencies
- Health monitoring and surveillance
- Access to information and education for healthcare professionals

Access to information for individuals is absent from the list, but 63% of responding organisations did claim to provide health information. Figure 2.7 shows the range of programmes included in the WHO survey.

| | |
|---|---|
| **Communication between individuals and health services** | |
| **Health call centres/ health care telephone helplines** | Health care advice and triage provided by trained personnel and pre-recorded messages; accessible on mobile phones or fixed lines. |
| **Emergency toll-free telephone services** | Free telephone hotlines for health emergencies provided by trained personnel and pre-recorded messages and linked to response systems; accessible on mobile phones or fixed lines. |
| **Communication between health services and individuals** | |
| **Treatment adherence** | Reminder messages provided by health services to patients aimed at achieving medication adherence using mobile ICT*; messages can be text, voice or multimedia. |
| **Reminder to attend appointments** | Reminder messages provided by health services to patients to make or attend an appointment using mobile ICT; message can be text, voice or multimedia. |
| **Community mobilization/health promotion campaigns** | Health promotion campaigns conducted using mobile ICT to raise the awareness of target groups. Messages conveying information can be text, voice or multimedia. |
| **Consultation between health care professionals** | |
| **Mobile telehealth** | Consultation between health care practitioners or between practitioners and patients using mobile ICT. |
| **Intersectoral communication in emergencies** | |
| **Emergency management systems** | Response to and management of emergency and disaster situations using mobile ICT. |
| **Heath monitoring and surveillance** | |
| **Health surveys** | Data collection, management and reporting of health surveys using mobile ICT. May involve any combination of networked mobile devices. |
| **Surveillance** | Routine, emergency and targeted data collection, management, and reporting for public health surveillance using mobile ICT. May involve any combination of networked mobile devices. |
| **Patient monitoring** | Data capture and transmission for monitoring a variety of conditions in a range of settings using mobile ICT. |
| **Access to information and education for health care professionals** | |
| **Access to information, resources, databases and tools** | Access to health sciences literature, resources and databases using mobile ICT. |
| **Clinical decision support systems** | Access to decision support systems using mobile ICT. |
| **Electronic patient information** | Access to electronic patient information (such as EHR/EMR, laboratory results, X-rays, etc.) using mobile ICT. |
| **mLearning** | Access to online educational resources using mobile ICT. |

Figure 2.7 Types of mHealth programme included in WHO 2016c survey

### 2.3.1. MHealth developments across the globe

Individuals and national health organisations have been very quick to see the potential of mobile technologies for healthcare, in a wide range of clinical and home settings. In very recent years, mHealth has developed rapidly, particularly in developing countries “where mobile communications technology has greater reach into priority populations than that of health services, the internet, and fixed telephone lines. Even in developed countries, people are discontinuing fixed phone and internet connections in favour of mobile ones… but in

developing countries, mobile communications technologies are leapfrogging several stages of technology development into remote areas that may never have infrastructure for sufficient fixed telephone lines or computers" (WHO, 2016c)

Early experiments were carried out even before the rise of the smartphone, when SMS messages represented the state of the art. In 2014, Bogart et al reported on an exploration of "the feasibility and acceptability of using SMS messages for an aftercare plan service to improve medication adherence of psychiatric patients using antipsychotic medication" (cited in Househ, 2014). Results showed that "SMS reminders for medication adherence in psychotic patients are helpful and provide a minimally invasive and cost-effective measure to improve antipsychotic medication adherence".

In Germany, Haug et al (2013) found that SMS-based smoking cessation programs can reduce smoking in teens, especially those 18 years of age and older, while in the US, a study on public health communication and alert fatigue found that although sharing messages through SMS was effective in communicating between public health agencies and providers, "frequent information delivery through numerous communication channels had a negative impact on healthcare providers to recall the information sent to them. The study recommends re-examining the frequency of SMS messages sent out in order to improve the recall of information by public health providers during emergencies" (Baseman et al, 2013, cited in Househ, 2014). Other studies have used SMS in studies that medication adherence, disease prevention, public health, psychiatry, collection of data, and so forth. Househ's meta-review of systematic reviews in this field concluded, "There is low to moderate evidence that SMS-based interventions in healthcare can provide benefit in appointment reminders, for developing countries, and in preventive healthcare. … Although there are studies that examine the impact of SMS in the short term (e.g. 1 week to 3 months), more studies are needed to examine more long-term (e.g. 1 year and more) impact of SMS on health outcomes" (Househ, 2014).

The quasi-ubiquity of smartphones has brought the potential for richer forms of communication than text messaging to, though this still has strong benefits. A

good example is that mSehat, an integrated, Android and web-based, multimedia-enabled mobile health platform for frontline health workers, which includes “accredited social health activists, auxiliary nurse midwives and health programme managers. mSehat was named after the Hindi word for health, “sehat”, and assists these workers via an integrated service-delivery platform accessible via smartphones, tablets and web-based dashboard reporting. Since October 2015 mSehat has been implemented in five districts of Uttar Pradesh (Bareilly, Faizabad, Kannauj, Mirzapur and Sitapur), chosen because they were among the 25 identified high-priority districts in the state” WHO, 2016c). The goal of the programme is to accelerate the reduction of maternal, neonatal, child mortality and total fertility rate in Uttar Pradesh, where the numbers of health workers available to advise and care for new mothers is extremely low. Smartphones and tablets were provided to 12 000 workers in the five districts to mSehat’s multimedia content, which includes visual material together with voice and text messages in local languages. The programme has been evaluated and it has been found that the main benefits for health workers include “their ability to better counsel, persuade and manage beneficiaries using vernacular, multimedia enabled, intelligent (uses individual service delivery data to guide health information delivery) job-aids. For individual women, they appreciate receiving services alerts and health information as SMS and voice calls in their local language, which has meant improved health indicators of mothers, babies and families (WHO, 2016c).

There are now published systematic reviews of mobile technology employed in interventions across various health conditions such as smoking cessation, weight loss, anxiety, diabetes management, eating disorders, alcohol use, and healthy eating and physical activity.

### 2.3.2. MHealth apps for obesity and related conditions worldwide

Currently, commissioned weight loss services and interventions in Europe and the USA often start by considering the use of an appropriate combination of diet, exercise programme and counselling for the individual – drawing on behaviour change theories (Blackwell et al ,2013; Khaylis et al, 2010;Levy, 2007). The case for employing mobile electronic technologies has been stated to be that it has the advantage of portability and can be used outside the

healthcare setting (and the home) as people go about their daily lives (Heron et al, 2010). The use of mobile technology for weight loss, obesity management and diabetes care is now increasingly accepted: a recent analysis of app store catalogues identified more than 97,000 mHealth apps, most of them dealing with general health and physical fitness. (MHMR, 2015, cited in Mateo, 2016)

Bardus et al's (2016) systematic review and meta-analysis provides a good overview of work in this field globally. This reported on 270 publications on mHealth apps for weight loss. Examples of studies describing *design and development* and *usability* included testing of research-based apps or commercial apps such as MyFitnessPal for weight management and physical activity. Other articles presented details on the design; in addition, they evaluated the effects of technologies on physical activity behaviour using. Several reported on the development and usability of apps for dietary interventions. Others focused only on text messaging to support weight loss among a variety of populations and settings" (Bardus et al, 2016). Many of the apps described used social media, either alone or integrated with other functionality.

In a smaller study, focussed on the efficacy of such interventions, Mateo et al examine data from twelve studies of mobile apps for weight loss. Their conclusion is that "the results from this meta-analysis demonstrated that interventions based on mobile phone apps are associated with more weight loss than other types of interventions. Furthermore, a non-significant increase in physical activity was detected. Evidence from this meta-analysis shows that mobile phone app-based intervention may be useful tools for weight loss" (Mateo et al, 2015).

### 2.3.3. MHealth in Saudi Arabia

Because of the widespread of mobile phones in the region, governments, health professionals, and entrepreneurs are increasingly looking at mobile as a potential means to address health issues and promote healthier lifestyles (Sabbagh, 2012). Akbar and Fernendez-Luque's 2016 review found a total of 1,820 medical and mobile health apps already available in the various app stores, across all platforms. They also identified strong growth: the apps created

in the first quarter of 2016 are more than all the apps created in 2015, and more than all apps created from 2011 to 2014. 28% of the apps have more than 5,000 (Akbar, p. 413). Some commercial mHealth apps launched in recent years in Gulf countries such as:

- Es3efny (which means in English “aid me”) provides an effective way of communication between the ambulance and the hospital.
- Faselty, a Blood Donation Mobile App. based on location and blood types. It aims to make it easy to connect blood donors with people in need.
- A mobile health service enabling users to receive personalised health tips on their mobile has been established from Telecom Company in Qatar, AUE Kuwait, Iraq and Palestine.

There are several other programmes available or in development. In the commercial world, Radcliffe (2015) reports that in 2013 Vodafone Qatar and Weill Cornell Medical College (Qatar) launched a mobile app, available in English and Arabic, to promote exercise and healthy eating. Alongside a calorie counter, the app also uses a traffic light system to indicate how healthy or unhealthy different dietary choices are. A burger and fries, for example, displays a red light, whilst a more healthy option – like salad or fruit - would attract a green light.

Qtel meanwhile has launched an mHealth service for diabetics in Kuwait, Iraq and Palestine. Subscribers can receive personalized alerts and information on exercise and diet. With Ramadan fast approaching Kuwaiti diabetics can also benefit from specialist services such as a specialist Ramadan ‘App Service’ for Diabetics, potentially very important in a country where around 1 in 5 is diabetic. Other Ramadan Apps with a focus on physical health include those listed in the Google Play Store under categories such as Ramadan Recipes and Best Ramadan Recipes.

Alsulame et al’s (2016) review of current literature on eHealth in Saudi Arabia, concentrating on the scientific literature rather than commercial examples, identified five very different applications of mobile technology to health issues in the country.

Al-Dowaihi et al. describe an asthma-monitoring prototype system that supported asthma patients and medical staff advising them. “It offered the patients a smartphone application to monitor their asthma condition by receiving their peak flow readings from a peak flow meter and comparing them with the normal peak flow readings stored in the system.”

A similar self-monitoring application was developed by Alanzi et al. (2014). The researchers evaluated the Saudi Arabia Networking Aiding Diabetes (SANAD) system, which used a smartphone diabetes management module to collect blood glucose records from Saudi Type 2 diabetes patients. “Among 33 participants, 80% of the patients found the SANAD system was helpful in diabetes management”].

In the field of dermatology, Kaliyadan et al. (2013) evaluated the use of a 4G smartphone for mobile tele-dermatology. A dermatologist used the mobile to take photos of patients' skin, made a diagnosis and sent the photo to another dermatologist to compare both diagnoses. The agreement of diagnoses was high among dermatologists. A questionnaire to assess patient satisfaction was administered to each of 166 consecutive patients, the majority of whom were “highly satisfied with tele-dermatology” (ibid).

A rather different extension of the term “mHealth” is in e-learning for medical education. Alghamdi et al. (2013) used mobile phones to help students understand health content and application structures, diabetes prevention and educational applications. “They found that screen size had no statistically significant impact on user understanding of the health information contents, although larger screen size allowed participants to read the characters more quickly with less effort. Overall, although these studies showed positive results, mobile health has had limited uptake by organizations”.

The annual Hajj season brings two million pilgrims to the Kingdom, with accompanying health issues. Nafea et al (2014) report on the use of a platform for sharing electronic health records between the Health ministry and the Hajj ministry to keep pilgrims’ health records online by using special mobile devices. It is hoped that this environment will provide a pre-emptive rather than a reactive approach to health problems, reducing the time and cost for healthcare

delivery. The mechanism proposes a patient locator framework during performing Hajj by monitor and tracking patients based on the proposed special device.

These examples show that there is interest in developing mHealth apps in Saudi Arabia across a number of different types of health issue and functionality type. However, as Alsulame et al point out, “although these studies showed positive results, mobile health was used by only a few departments within a few organizations” (Alsulame, 2016).

### 2.3.4. MHealth applications for obesity and related conditions in Saudi Arabia and the Gulf

Mobile apps relating to obesity and related conditions would appear a good “fit” with Saudi Arabia, given on the one hand the gravity of the obesity epidemic and on the other, the penetration of mobile use in the country, where apps are commonly used, especially by the digital generation (see above, 1.2). This also applies to other Gulf countries such as Qatar, Dubai and so on. In addition to the commercial apps mentioned above, available across the Middle East, a number of apps address the Saudi or Gulf context. In this section, we review the literature on this topic, concentrating on accounts of a subset of these systems.

In 2012, Kurdi et al described the development of an Android application, the Personal Diet Assistant, to encourage the adoption of a healthy diet, as part of the drive against obesity in KSA. The researchers felt that the development of a specifically Arabic application was important, and began their project with a questionnaire to potential users, asking about previous use of mobile health apps. Interestingly for this study, they report that at that time (2010-1) they “received very few responses due to scarcity of diet applications in the Arabic language, lack of Arab users for these applications, as well as low level of awareness of obesity-associated problems” (Kurdi, p. 491). They based their specification for the app on three existing diet apps, two English language (DietPoint and LoseIt) and one in Arabic, Myzan Alrshaqt. The resulting design includes the following functionality with an Arabic language interface:

- Has a pool of healthy diet plans
- Suggests a shopping list for each diet plan

- Alerts the user for meal times
- Allows tracking weight and body measures
- Finds the nearest gym based on the user's current location
- Calculates Body Mass Index (BMI), Basal Metabolic Rate (BMR) and daily energy expenditure
- Provides password-secured access to data and information

The application therefore addresses both calorie intake (diet plans, shopping, food times) and energy output (gym location, energy expenditure tracking). This is a common model for consumer level fitness apps. Unfortunately, there have been no publications on myPDA since 2012.

In a number of publications, Alnasser et al (2015; 2016a; 2016b) have consistently taken a user-focussed approach to the development of a weight loss app named Twazon and aimed at Saudi women in particular. The researchers took a two-pronged approach to design, soliciting user requirements from potential users on the one hand (Alnasser et al, 2015) and carrying out a structured review of mHealth apps against an evidence-based public health framework for countering obesity (Alnasser et al, 2016a). The requirements study consisted of focus groups with 39 volunteers, who were asked to describe their thoughts and ideas about the features of a number of existing apps: "they were asked what they liked, disliked, and would ideally like a weight loss app to have. Their experience of previous weight loss diets was also discussed to identify their opinions of barriers to weight loss" (Alnasser, 2015, p. 2) In addition to lack of willpower and procrastination, inadequate social support, lifestyle, customs, and family obligations such as parties figured as obstacles to improved diet:

> We don't have many entertainment places, so we meet in food places, restaurants, or friends' houses and everything calls you to eat, as well as girls today are good cooks, they make delicious sweets and you have to eat to keep up with them. [Participant 2; FG 3]

The researchers also note that from the discussions, it was clear that the majority of participants also had incorrect information or beliefs about weight loss, e.g. "You can put 3 bags of salt in your bathtub 3 times a week and that helps lose weight" (ibid, p. 4). In their 2016 "competitor app" study, the researchers identified 65 health and fitness applications aimed at the Arab-

speaking market and analysed their functionality in terms of providing the following functions, identified by Breton et al (2011):

1. determining and explaining BMI,
2. recommending and tracking daily servings of fruit and vegetables,
3. recommending daily physical activity,
4. advising the user to drink water instead of soda or juice and tracking their daily intake of water,
5. allowing for the recording of daily food intake,
6. providing a calorie tracker to maintain calorie balance,
7. providing weight-loss goals of 1–2 lb/week,
8. providing information about portion control,
9. recommending that the user read and understand nutrition labels,
10. providing a way to track weight,
11. providing a way to keep a physical activity journal,
12. offering suggestions for meal planning, and
13. offering a private social network or the capability of being linked to popular social media such as Facebook, Twitter, or Instagram for social support.

Information provision was the main function of most apps reviewed. Alnasser et al found that “most weight management guidelines take a multicomponent approach that includes diet, exercise, and behaviour modification. While the first two components are self-evident, behaviour modification (altering behavioural patterns through learned techniques) is largely overlooked in both English and Arabic weight-loss apps. The features of Arabic apps most commonly addressed meal planning practices or diet but placed little emphasis on modifying behaviour and daily physical activity” (p. 401). They also found that our “only two of the 65 Arabic apps we reviewed had a social networking feature, which was surprising given the cultural background of the users.

As a result of their design research, Alnasser et al went on to develop Twazon (“balance” in Arabic), which provides a wide set of functionality in accordance with Breton’s thirteen functions and with evidence from participants: for brevity, this is presented in Table 2.1:

| Practice | App Information |
|---|---|
| Weight assessment and goal setting | Assesses weight by calculating body mass index and waist circumference<br>Allows users to set their ideal weight, and sets a target date for achieving the weight loss goal<br>Calculates the number of calories needed daily based on their target weight<br>Recommends a decrease of at least 600 calories consumed per day in order to achieve weight loss goal |
| Healthy diet | Recommends daily servings/portions of all foods and beverages, including 6 cups of water per day<br>Recommendations given according to healthy lifestyle self-assessment score<br>Provides a customized healthy food palm based on the user's intake report<br>Recommends the reading of labels and describes how to properly read labels<br>Offers some suggestions for healthy food options in place of unhealthy food items.<br>Allows users to correct a poor meal/diet as an education tool for menu planning<br>Tips will be sent if the intake/activity ratio is off-balance according to healthy lifestyle self-assessment score |
| Physical activity | Recommends a minimum of 30 minutes of physical activity three times a week and allows users to assess their physical activity every 2 weeks<br>Tips will be sent if the amount of physical activity is low<br>Recommends taking at least 10,000 steps and provides a pedometer that tracks the daily number of steps |
| Self-monitoring | Allows users to track their daily food (calories) and water intake, and number of servings per food group, every<br>2 weeks<br>Allows users to self-assess their physical activity, every 2 weeks<br>Provides a weight loss tracker that informs user of current weight loss toward their goal weight (kg) |
| Social support | Provides an app-specific message board allowing users to privately share experiences, weight loss goals achieved,<br>and photos with other users<br>Allows users access to social networking services such as Twitter |

Table 2.1 Tools in Twazon addressing evidence-informed weight loss practices (Alnasser et al, 2016b).

In addition, thought has been given to presenting information in a readable and context-related manner, such as the use of the palm tree image as an infographic throughout the app to display food groups:


Figure 2.8: the Healthy Food Palm (Alnasser et al, 2016b).

Twazon represents a potential step forward from current commercial apps as “it has been designed in collaboration with final users, it complies with evidence-informed weight loss practices, it provides social-network access, and it includes a caloric content of Saudi local food” (ibid). It is currently (2017) being tested with 200 overweight and obese women from Riyadh, Saudi Arabia.

Both myPDA and Twazon address a wide, general audience. Mansar et al. add a further level of sophistication with personalisation, in their (2014) study of a system that “adapts the messaging content of a weight loss application to the context of its users while retaining an effective degree of automation. The adaptation addresses body image, eating and physical exercise habits and regional/cultural needs” (p.1). Drawing on the theory that dieting has cognitive, motivational and social aspects, the researchers developed a system that sends appropriate messages to users:

> To address the *cognitive* aspect, locally designed and tailored SMS messages can be sent daily to remind users of their goals. The *motivational* aspect can be addressed by a design feature in which participants enter incremental, achievable goals weekly. Participants can be asked to indicate daily whether they were successful in reaching each of their goals. In the *social* aspect of the application, social media can be leveraged. Participants can be invited to work toward a collective group goal (p. 3).

This is a useful, proactive extension to the information-provision model of mHealth apps, into which it could be extended. The paper discusses how surveying potential users can be used to build a profile of a target population, find common patterns, and then develop a database of text messages. The text messages are automated and sent to the users at specific times of day, as suggested by the survey results.

Finally, recent work by Albalawi and Sixsmith (2015) points to a way of increasing the effectiveness of public health messages, including those relating to obesity. They point out that as Twitter is widely used in KSA, providing the ideal opportunity to have a positive influence on the health of the country, identifying “opinion leaders” in this new medium could be valuable knowledge for public health actors targeting obesity-related behaviour. Their study aims to identify and profile the most influential Twitter accounts in Saudi Arabia, resulting in the identification of “25 religious men/women, 16 traditional media, 14 sports related, 10 new media, 6 political, 6 company and 4 health accounts”. Like Mansar et al’s work, the perspective taken by Albalawi and Sixsmith has the potential to increase the effectiveness, of mobile health apps, particularly any social media aspect.

Most of these studies concentrate on design and, to a lesser extent, efficacy. However, user attitudes to acceptance of these technologies are little discussed. Radcliffe suggests that acceptance may be an issue, warning that the Middle East and Saudi Arabia may be slower than the West to adopt mHealth solutions. Radcliffe (2015) suggests that in the Middle East “this (adoption) curve may be a little slower, not least because some users are cautious about a few of the activities required by many mHealth apps. In particular, data sharing, buying medication online or interacting remotely with health care professionals provokes some unease across the age spectrum”.

Radcliffe bases this warning on Booz & Co.’s (2013) study of the Arab Digital Generation (ADG), a collaboration between Booz & Company and Google, based on a survey study of more than 3,000 digital users in nine different countries in the region, which highlights the impact of technology on society, as well as future trends. The participants included people born between 1977 and

1997, representing 40 per cent of the entire MENA (Middle East and North Africa) population. When asked about e- and m-Health, the report observed that “the ADG researches medical services and information online, but still prefers to deal with an individual face-to-face.” The research noted that “only 27 per cent of respondents are comfortable with having an online consultation with a medical professional; another 45 per cent are either 'not comfortable' or 'not at all comfortable.'“ As a result, the study concludes that efforts to bring technology into healthcare “must strike a delicate balance that acknowledges privacy considerations and other sensitivities.”

As can be seen from these examples, technology acceptance of mHealth applications has not been the typical perspective of mHealth researchers, who have been mostly concerned with interaction design, content, underlying model of behaviour change and, where apps are implemented and evaluated, efficacy in changing behaviour. A good example is Lyzwinski’s (2014) systematic review of mHealth weight loss apps, a major piece of work covering 2396 studies, which concentrated on efficacy and theoretical models underlying mHealth applications, with the following research questions in mind:.

> Do mobile devices induce weight loss and favourable changes in diet and physical activity when compared to baseline weight and scores? Do they induce weight loss when compared with standard controls receiving no intervention and or when compared with controls receiving non-mobile weight loss interventions?
>
> What health psychology theories and psychological behaviour change techniques inform mobile device weight loss intervention design and are theoretical predictors along the causal pathway leading to weight loss improved post-intervention?”

In a follow up study in 2017, Lyzwinski et al concentrated on consumer issues, mostly to do with design issues:

> The five key themes concerning text messages for weight loss involved a careful consideration of personalization, message tone, structure, frequency and content. Key optimization themes for weight loss apps were personalization, simplicity with appeal and engagement/entertainment. Common identified benefits of mHealth for weight loss included self-monitoring, goal setting, feedback, ability to motivate, educate, and remind. Common

barriers users identified were related to technological and psychological issues as well as message overload/inappropriate timing of messages.

The authors highlight the need to personalise mHealth apps and to pay attention to different target group demographic requirements and preferences.

Mobile healthcare may still be in its infancy across the Middle East, but these examples begin to demonstrate the breadth of potential health related activities mobile can support. In itself, mobile technology will not provide solutions to the health issues the region faces, but it can play a role in promoting and supporting improved health outcomes for people of all ages. This study aims to investigate user acceptance of consumer level mHealth applications that support the health needs of overweight people in Saudi Arabia, determining the factors that affect user acceptance and adoption of mHealth application, particularly the intention to use and continued usage for fitness applications.

This review of mobile apps brings us closer to the heart of the research aim for this thesis, pointing to implemented examples of mobile health apps for obesity in a Middle Eastern setting, which will be particularly useful when setting out the context for our questionnaire study. It also references the obstacles to mHealth acceptance that developers have uncovered.

## 2.4. Acceptance of Innovations

In spite of the advancement and variety of available mobile-based applications, there is still a need to investigate the current position of acceptance of mobile health applications, if existing obstacles to use are to be understood and overcome (Mohamed et al, 2011). In this section, we introduce the background for the various models currently used to explain technology acceptance decisions and introduce their most widely used variants.

### 2.4.1 Diffusion of Innovations

The study of the acceptance of technology has grown out of the broader disciplinary area known as “the Diffusion of Innovations”. Everett Rogers (1962/1995/2010), developer of the best-known diffusion of innovation theory, defined diffusion as " the process in which innovation is communicated through certain channels over time amongst the member of a social system” (Rogers, p.

10). Rogers' framework provides "a standard classification scheme for describing the perceived attributes on innovations in universal terms" (Rogers, 1995). Rogers identifies five stages in the adoption process, which apply to ideas and behaviour in any realm of activity, though Rogers' own focus initially was on innovation in farming methods in the US after the Second World War. The five stages are set out in Table 2.2:

| Stage | Definition |
|---|---|
| Knowledge | The individual is exposed to an innovation, but lacks information about it. During this stage, the individual has not yet been inspired to find out more information about the innovation. *For instance, someone might notice a friend swiping their debit card to pay a fare*. |
| Persuasion | The individual is interested in the innovation and actively seeks related information/details. *For instance, the friend might be asked about the facility, or the potential user might ask a company employee for details.* |
| Decision | The individual takes the concept of the change, weighs the advantages/disadvantages of using the innovation and decides whether to adopt or reject it. *In our example, the potential user decides whether or not to ask his bank for a swipe-enabled card.* |
| Implementation | The individual employs the innovation to a varying degree depending on the situation. During this stage, the individual also determines the usefulness of the innovation and may search for further information about it. *Perhaps the user is still worried about security and seeks reassurance from his bank*. |
| Confirmation | The individual finalises his/her decision to continue using the innovation. *The user throws away his old non-swipe card, perhaps.* |

Table 2.2: Rogers' five stages of the adoption process

Rogers' model studies diffusion within a change communication framework to examine the effects of all the components involved in the communication process on the rate of adoption. He suggested five variables of innovations by which an innovation can be described, and showed that individual receiver's perceptions of these attributes predict an innovation's rate of adoption. Rate of adoption is the relative speed with which an innovation is adopted by members

of a social system. The five variables are Perceived Attributes of Innovation, Type of Innovation-Decision, Communication channels, Nature of the Social System and Extent of Changing agent's promotion efforts, as presented in Table 2.3:

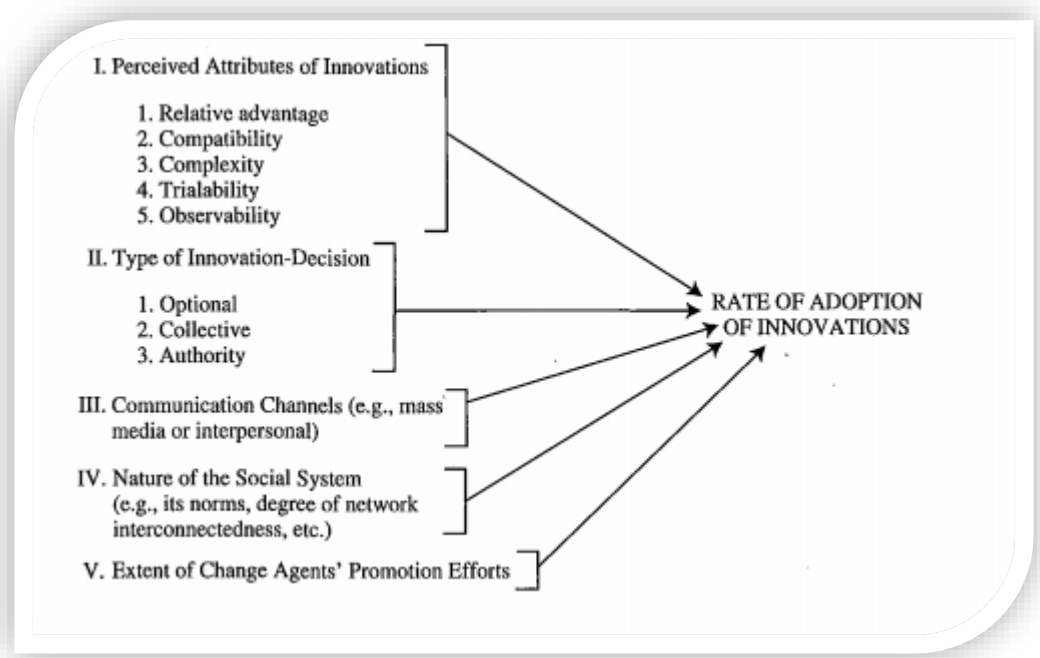



Table 2.3 Variables Determining the Rate of Adoption of Innovation (Rogers, 1995)

How the adopter *perceives the attributes of the innovation* has an impact on the process of adoption. The relevant characteristics identified by Rogers are:

> *Relative advantage*: the degree to which an innovation is perceived as better than the idea it supersedes. The underlying principle is that the greater the perceived relative advantage of an innovation, the more rapid its rate of adoption
>
> *Compatibility*: the degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters
>
> *Complexity*: the degree to which an innovation is perceived as difficult to understand and use
>
> *Trialability*: the degree to which an innovation may be experimented with on a limited basis. If an innovation is trialable, it results in less uncertainty for adoption

*Observability*: the degree to which the results of an innovation are visible to others. The easier it is for individuals to see the results of an innovation, the more likely they are to adopt it.

In addition, adoption decisions may be of *different types*, and this will have an impact on the comparative importance of not only the variables but also the characteristics listed above. In Rogers' model, decisions may be:

*Optional*: an individual has the flexibility to use a technology or not. Consumer goods are in this category.

*Authority-based*: adoption may be imposed. For instance, an institution may introduce a new email system. This yields the highest rate of adoption, but produces high resistance.

*Collective*: this type of decision achieves a balance between maximum efficiency and freedom. For instance, a particular industry might to adhere to a particular standard for its products, without top-down pressure.

*Communication channels* about the innovation may be interpersonal or involve media, including mass media. Communication is closely related to the final variable, the social system and the role of change agents.

The *social system* is defined as "a set of interrelated units that are engaged in joint problem solving to accomplish a common goal. The members or units of a social system may be individuals, informal groups, organizations, and or subsystems" (Rogers, p. 23). All members cooperate at least to the extent of seeking to solve a common problem in order to reach a mutual goal: Sharing of a common objective binds the system together. The social system affects the innovation's diffusion in several ways, depending on the specifics of the Social structure, communication structure and social norms.

The final element is the opinion leader or change agent. "Opinion leadership is the degree to which an individual is able to influence other individual's attitudes or overt behaviour informally in a desired way with relative frequency. The rate of adoption is also influenced by the extent of changing agent's promotion; the more opinion leaders the change agent can convert, the greater the rate of adoption" (Rogers, p. 27). Rogers observed that "the rate of adoption is greatest when opinion leaders adopt, and continues to grow with little promotion by change agents after critical mass of adopters have been established".

According to Rogers, potential adopters of new and innovative technologies can be categorized in five clusters: Innovators (risk takers), Early adopters (hedgers, Early majority (waiters), Late majority (sceptics) and Late adopters (slowpokes). Considering the distribution of each of the adopter types across the whole population, Rogers states that about 2.5% are early innovators, 13.5% are early adopters, 34% are early majority, 34% are late majority and 16% are laggards.

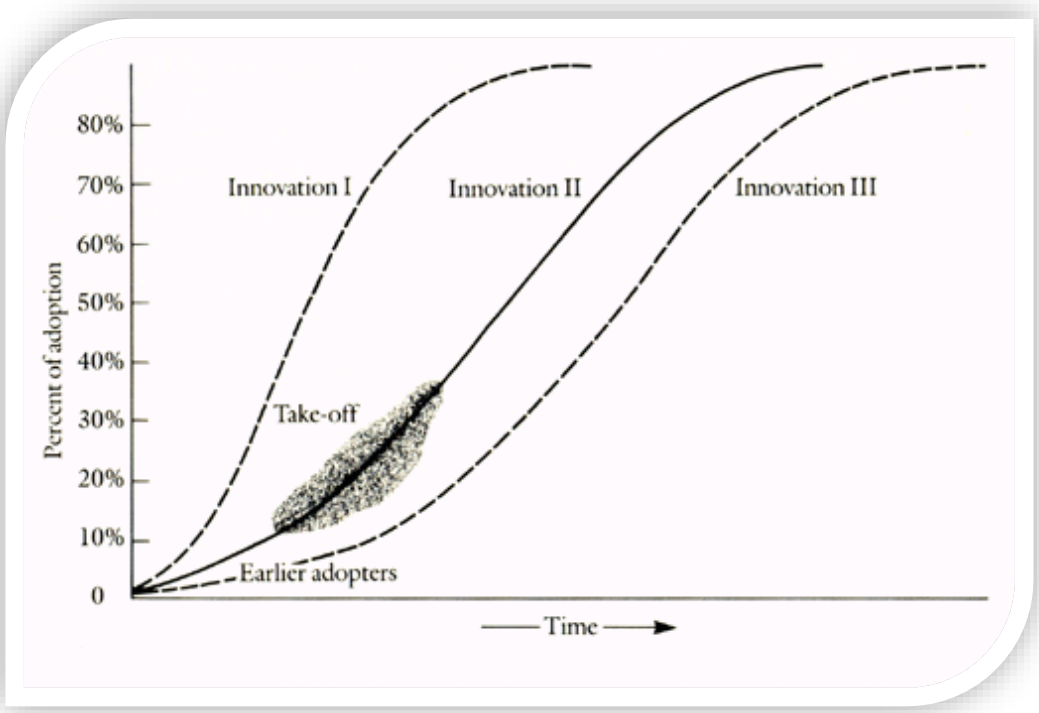



Figure 2.9 Diffusion of Innovations adopted from Rogers (1995)

**Innovators:** Innovators are the consumers who are the very first using innovations (Rogers, p. 22). Innovators are willing to take risks, have the highest social status, have financial liquidity, are social and have closest contact to scientific sources and interaction with other innovators. Their risk tolerance allows them to adopt technologies that may ultimately fail (Rogers, p.282)

**Early Adopters:** These individuals have the highest degree of opinion leadership among the adopter categories. Early adopters have a higher social status, financial liquidity, advanced education and are more socially forward than late adopters. They are more discreet in adoption choices than innovators. They use judicious choice of adoption to help them maintain a central

communication position failure (Rogers, p.282). A more commonly known word of describing this opinion leadership might be trend setting.

**Early majority:** They adopt an innovation after a varying degree of time that is significantly longer than the innovators and early adopters. The Early Majority have above average social status and contact with early adopters but seldom hold positions of opinion leadership in a system (Rogers 1962, p. 283).

**Late Majority:** They adopt an innovation after the average participant. These individuals approach an innovation with a high degree of scepticism and after the majority of society has adopted the innovation.

**Laggards:** They are the last to adopt an innovation. These individuals typically have an aversion to change-agents. Laggards typically tend to be focused on "traditions", lowest social status, lowest financial liquidity, oldest among adopters, and in contact with only family and close friends (Rogers 1962, p. 283).

For Ellsworth (2000), the most critical benefits of Rogers' model come from his identification of innovation attributes: "Practitioners are likely to find this perspective of the greatest use if they are engaged in the actual development of the innovation or if they are deciding whether (or how) to adapt the innovation to meet local requirements…Rogers' framework can be useful in determining how it is to be presented to its intended adopters" (p.40). When considering the diffusion process of new innovative mobile health technologies it is vital to focus on the behavioural intention of the user first.

As the “decision” stage of the innovation adoption process is the most difficult for which to acquire empirical evidence (Rogers, p. 83), it has attracted much attention from researchers, and a number of models have been developed to explain this stage in particular. Of these, the Technology Acceptance Model, an information system theory that models how users come to accept and use a technology, has been most widely applied in Information Systems. Thus, it is essential for anyone willing to study user acceptance of technology to have an understanding of the Technology Acceptance Model (Chuttur, 2009).

### 2.4.2. Technology Acceptance Models

Technology acceptance is a subfield of Information Systems, developed out of Innovation Diffusion, which studies people's acceptance and use of innovations in the area of technology. In its various manifestations it has been used to study everything from location tracking of children by parents (Vasalou et al, 2012) to conversational robots for the elderly (Heerink et al, 2008).

In the current literature on Information Systems (IS), attitude is seen as an important aspect as it represents the tendency or orientation of users. An attitude is defined as a state of mind regarding objects or ideas by which an individual's behaviour is influenced (Fishbein, 1967). It can be said that attitudes represent an individual's feelings, opinions, and position and action tendencies towards objects or ideas. Scholarly research has focused on attitudes of IS users as an important subject which has resulted in a large body of literature focusing on user acceptance and the use of IS. For example, the Technology Acceptance Model (TAM), proposed by Davis (1989), describes determinants of users' attitudes and intentions towards new technologies (Davis, 1989). The major constructs were perceived ease of use, perceived usefulness, use intentions and actual use. Davis' is the most influential model in this area. These basic constructs have continued to be used by researchers, with numerous extensions and modifications. Numerous studies have since examined the relationships between perceptions and attitudes, behavioural intentions and actual behaviours.

#### *2.4.2.1 Technology Acceptance Model (TAM)*

In 1989, Davis described the Technology Acceptance Model (TAM), to remedy the lack of "valid measurement scales for predicting user acceptance of technology" (David, 1989, p. 319). "Most subjective measures used in practice are unvalidated, and their relationship to system usage is unknown. The present research develops and validates new scales for two specific variables, perceived usefulness and perceived ease of use, which are hypothesized to be fundamental determinants of user acceptance" (ibid). Perceived usefulness is "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989, p. 320). Perceived usefulness and perceived ease of use contribute in the creation of an attitude

towards using technology, see Figure 2.10. TAM can also be applied to non-work settings. Here, “the goal becomes personal objectives instead of enhancing job performance. For example, a PU goal or "job" of a health care consumer in selecting a physician (using web-based data) hypothetically is to identify a highly qualified medical practitioner. In this circumstance, web based information is useful to the extent it helps achieve the latter goal” (CHIRC, 2017). Davis (1989) defined PEOU as "the degree to which a person believes that using a particular system would be free of effort" (p. 320). Here, PEOU's definition, unlike PU's, transcends work settings as well as goals or purposes.

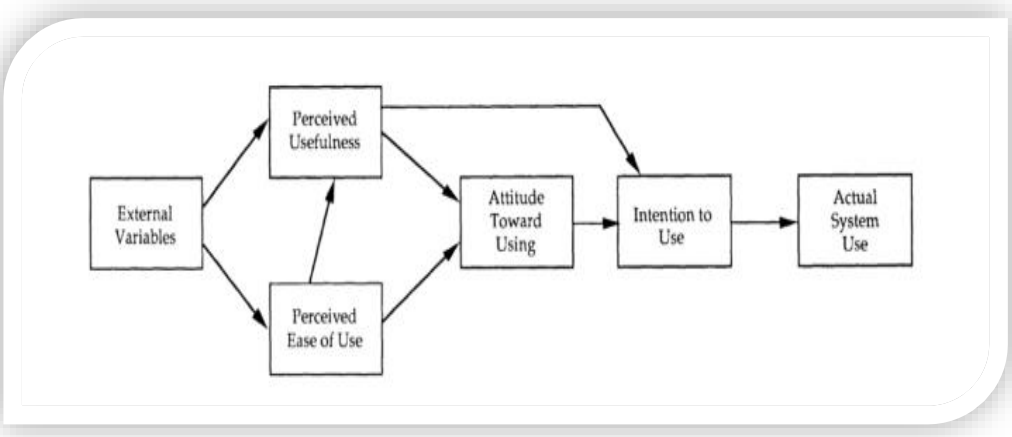



Figure 2.10. TAM (Davis et al, 1989)

The connection between perceived ease of use and perceived usefulness indicates that the level of user-friendliness would affect perceived usefulness in the information system. If the system has high user-friendliness, this will most likely increase the level of satisfaction for the user, and make the system appear more useful. On the other hand, the perceived ease of use has no direct link to intention to use the technology. Davis concluded, "perceived usefulness is a major determinant of people’s intentions to use computers." (Davis, 1989, p.997). The TAM model's validity and reliability were established in two studies. Davis' instrument included “six items to measure PU and six items to measure PEOU. The first study compared workers' perceptions of usefulness in addition to the ease of use of implemented technologies from workers' self-reported use of these technologies. Some users of computer-based electronic mail (containing file editor software) rated their PU and PEOU respectively and

reported the extent each was actually used. Using pooled data for both technologies, the instrument's Cronbach Alpha reliabilities were high for both PU (.97) and PEOU (.91) in the first study. Both PU and PEOU were significantly correlated with self-reported use of these systems ($r = .63$ and .45, respectively; $p < .001$).

The second study included a different group of workers in a non-work setting. In this study workers were asked to rate the PU and PEOU of computer graphics systems that were not in current use and to prospectively predict future adoption" (CHIR, 2017). It is important to note that self-reports of current and probable future adoption were used in these and studies, and in the TAM tradition as a whole, rather than any form of empirical measure of actual use.

Originally, TAM was applied to adoption of technology in the workplace and it has mainly continued to be used in work settings. For instance, the CHIRR (2017) note its use in research assessing "the acceptance of HITs, such as personal digital assistants (Yi, Jackson, Park, & Probst, 2006)…and telemedicine technology (Hu, Chau, Liu Sheng & Kar Yan, 1999)". TAM also has been integrated with motivational theory (Davis, Bagozzi, & Warshaw, 1992), resulting in an extended model in which PU is paired with external motivation (EM) in the PU-EM scale. TAM also has been used to measure consumer acceptance of consumer health IT such as m-health, e-health and telemedicine research (Or et al., 2011). A recent review urged the application of the TAM in more consumer health informatics studies (Keselman, Logan, Smith, Leroy, & Zeng-Treitler, 2008).

The TAM has the advantage of being simple and parsimonious. However, researchers have felt the need to include a number of other explanatory concepts, which has led to the creation of extended TAM-based models. Some extensions of TAM, in addition to the EM-PU work mentioned above, have been TAM 2 (Venkatesh & Davis, 2000) and the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh, 2003). Among the variables added to these extended models is subjective norms in TAM 2 and social influence in the Unified Theory of Acceptance and Use of Technology involving questionnaire item such as "People who are important to me think I should use the system."

### *2.4.2.2 Unified Theory of Acceptance and Use of Technology (UTAUT)*

The Unified Theory of Acceptance and Use of Technology (UTAUT), is based on the integration of eight other models from user acceptance. UTAUT was formulated with four core determinants of intention and usage, and up to four moderators of key relationships. UTAUT was then tested using the original data and found to outperform the eight individual models. The UTAUT uses four factors, which are Performance Expectancy, Effort Expectancy, Social Influence and Facilitating Conditions. The first three factors are direct determinants of usage intention and behaviour, while the fourth is a direct determinant of usage behaviour. This last item was missing from TAM, but is intuitively vital to actual adoption: without the necessary technical infrastructure, for instance, a system will not be adopted or adoptable. The demographic variables (age, gender, experience and voluntariness of use) moderate the impact between factors (independent variables) and behavioural intention and use behaviour (dependent variables).

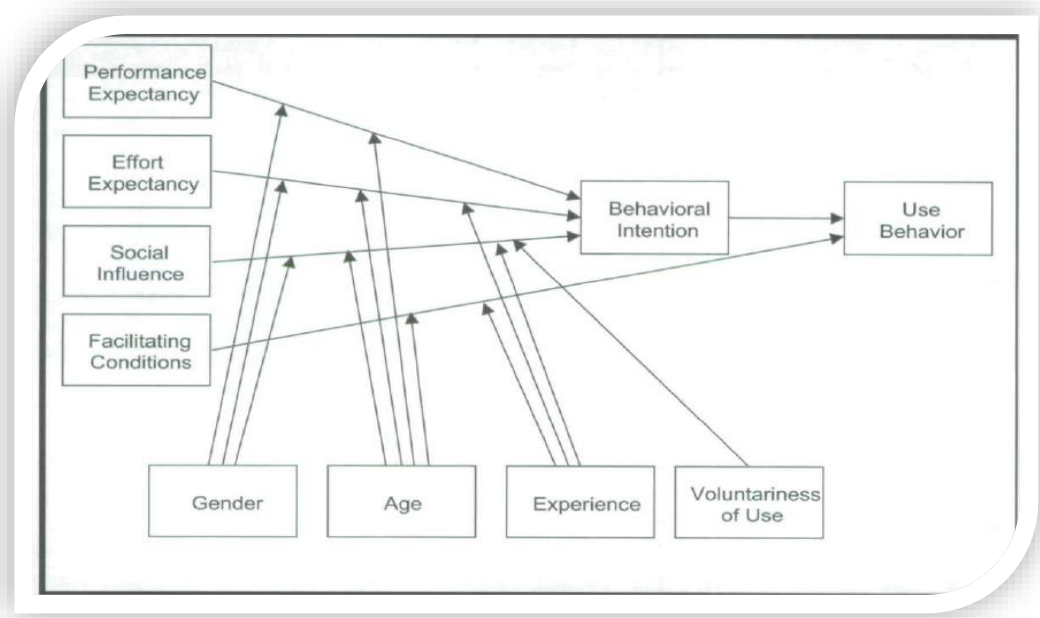



Figure 2.11 Unified Theory of Acceptance and Use of Technology (UTAUT)

The UTAUT model reworked TAM, identifying four main factors that influence user acceptance and use of new technologies: performance expectancy (PE),

effort expectancy (EE), social influence (SI) and facilitating conditions (FC). *Performance expectancy* can be defined as the extent to which the user believes that using a specific innovation would enhance overall performance (Venkatesh et al., 2003). The concept of PE reflects the idea of usefulness used in the TAM. *Effort expectancy* can be defined as the extent to which the user feels that utilizing a specific innovation is simple or free of exertion (Venkatesh et al., 2003). This concept reflects the concept of perceived ease of use used in TAM, but also includes the idea of complexity. The effect of perceived usefulness (performance expectancy) and ease of use (effort expectancy, complexity ) was empirically examined and found that it has a significant impact on intention to use in many contexts, including internet applications (Moon & Kim, 2001; Ong, Lai, & Wang, 2004). *Social influence* can be defined as the "degree to which an individual perceives that important others believe he or she should use the new system (Venkatesh et al., 2003). It is accepted that social influence plays a main role in the intention of use and user acceptance of any technology (Malhotra & Galletta, 1999; Venkatesh, 2000). In a work setting, these could be authority figures who make the technology use mandatory rather than optional, or perhaps colleagues whose work would be made easier if all colleagues used the same system or standard. Finally, *facilitating conditions* are defined as the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system (Venkatesh et al., 2003, p. 454).

UTAUT is widely used and has attracted a number of studies that have suggested three types of extensions to the basic model:

> The first type of extension/integration examined UTAUT in new contexts, such as new technologies…, new user populations … and new cultural settings…The second type is the addition of new constructs in order to expand the scope of the endogenous theoretical mechanisms outlined in UTAUT... (Venkatesh et al, 2012)

For instance, Wang et al (2009) added two constructs (perceived playfulness and self-management of learning) to the UTAUT in their study of determinants of acceptance of mobile learning in 370 individuals in Taiwan. They found that these constructs were significant determinants of intention to use mobile learning in all respondents. Ben Messaoud et al (2011) found two new

constructs, Attitude toward Using Technology and Leadership, in a study that applied the UTAUT model to surgeons' adoption of robot-assisted surgery. “Finally, the third type is the inclusion of exogenous predictors of the UTAUT variables” (Venkatesh, 2012), for instance, Neufeld et al. (2007) explore the idea of charismatic leadership in technology acceptance.

As technology use has spread from the workplace to the home, adoption has become a personal consumer choice, a situation not well modelled in UTAUT. Since the current research concentrates on non-workplace situations, involving individual consumer choice, the TAM and UTAUT models discussed so far are not a perfect fit. This need to extend and modify general theories is to be expected. As Venkatesh et al suggest, “New contexts can result in several types of important changes in theories, such as rendering originally theorized relationships to be nonsignificant, changing the direction of relationships, altering the magnitude of relationships and creating new relationships. Each change can reveal the breakdown of theories that results in the creation of new knowledge (2012, p. 158).

#### *2.4.2.3 Extended Unified Theory of Acceptance and Use of Technology (UTAUT2)*

Therefore, based on a review of the extant literature, Venkatesh et al. (2012) proposed the extension of UTAUT, to what they termed UTAUT2, in order to tailor it to the consumer technology acceptance context. UTAUT2 incorporates a further three key constructs, positing that hedonic motivation, price value and habit also affect behavioural intention, the effects of which are moderated by different combinations of three of the original four moderators, gender, age and experience. Venkatesh et al.’s (2012) extension of UTAUT, compared with the original model, produced a substantial improvement in the explained variance of behavioural intention, from 56 per cent to 74 per cent, and also a significant improvement in the explained variance of usage, from 40 per cent to 52 per cent.

Whilst some models within the IS context have reached a relative level of maturity, the same cannot be said of UTAUT2 for which replication and generalisability studies, as well as those examining the model’s predictive

validity, are still much more limited in number. Venkatesh et al. (2012) suggested that future research should apply UTAUT2 in different countries, across different age groups, and on different technologies. It was also recommended that future

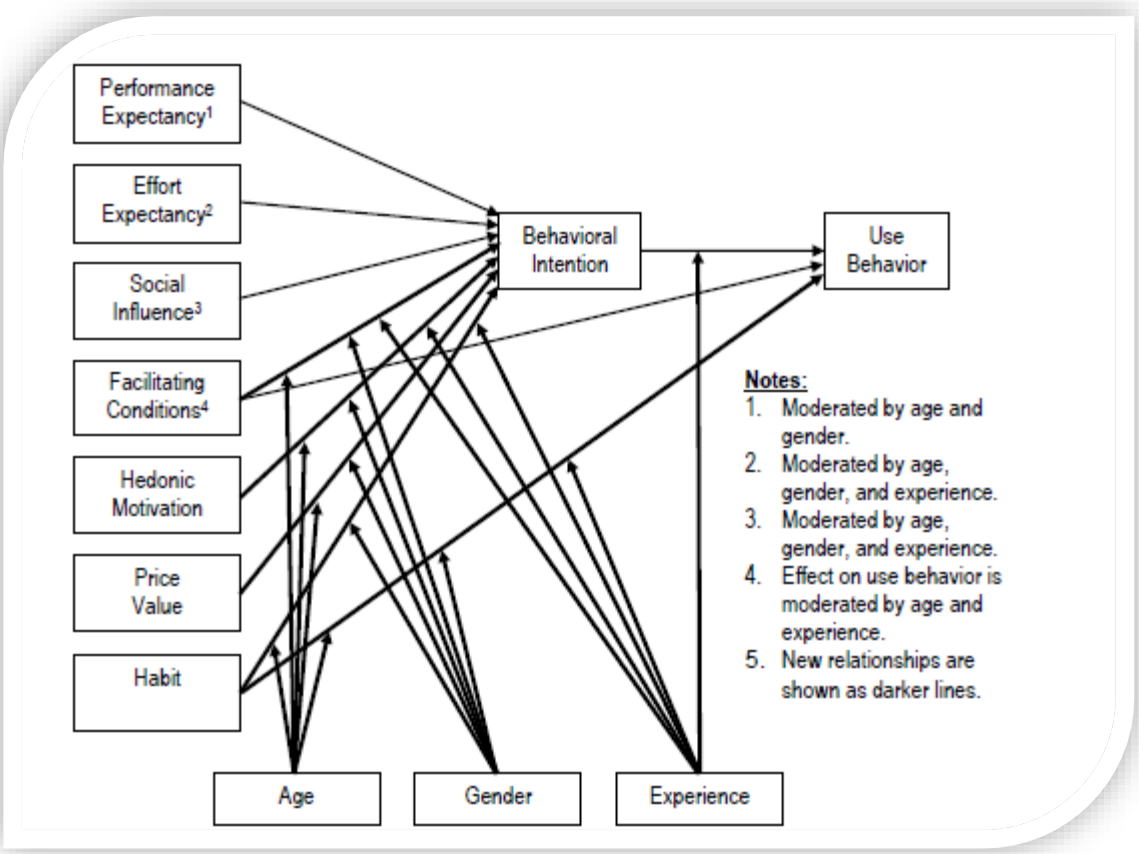



Figure 2.12 Extended Unified Theory of Acceptance and Use of Technology (UTAUT2)

research should attempt to identify other relevant factors to extend UTAUT2 thus providing support for this study. We have selected UTAUT2 as the core model in this study. The following are the details of the framework that has been chosen for this thesis.

Because UTAUT2 describes acceptance and use of new technology adoption in a consumer context, as opposed to employees in an organization, the importance of various factors has changed, and factors from UTAUT are

dropped and added. The fact that consumers can freely decide whether to adopt a new technology has the consequence that the moderating factor voluntariness of use is dropped in UTAUT2 (Venkatesh et al, 2012, p.159).

Three new "consumer-oriented" factors are introduced:

*a) Hedonic motivation*

Brown and Venkatesh (2005) define hedonic motivation as an enjoyment or happiness resultant from using a technology, and suggest that this plays a significant part in determining new technology adoption. "Both consumer behavior and IS research have theorized and found various constructs related to hedonic motivation (e.g., enjoyment) are important in consumer product and/or technology use (e.g., Brown and Venkatesh 2005…). They suggest that "[i]ntegrating hedonic motivation will complement UTAUT's strongest predictor that emphasizes utility" (Venkatesh et al, 2012, p. 158). This is clearly an important addition. Whereas the issue of whether a worker enjoys using their database or email system is rarely considered, a consumer's idea that they are likely to enjoy a games console or a phone app is intuitively an important factor in their decision-making around purchase and use. In this study, hedonic motivation will be understood as an individual's belief that using than mHealth app will be interesting and fun. Perceived enjoyment has been found to be a strong predictor of the adoption of the technology in a consumer context. For instance, as early as 2005, Bruner and Kumar investigating consumer acceptance of handheld devices found that "unlike what was found in a workplace context, the fun of using a device was a more powerful determinant of attitudes toward usage than the perceived usefulness of the device. Also, in contrast to previous findings where usefulness was found to have both direct and indirect (through attitudes) effects on BI, usefulness in the present study had no direct effects on BI" (p.555). Wang et al report Van der Heijden's (2004) contention that for hedonic systems, perceived enjoyment (a dimension of perceived playfulness) is a stronger predictor of behavioural intention to use than is perceived usefulness. In 2009, Wang et al's study of factors affecting mobile learning acceptance confirmed that perceived playfulness has a significant effect on behavioural intention to use Internet-based information

systems. Given that the usage of mLearning is fully voluntary and that the target user group consists of a large number of people with very diversified backgrounds, making an m-learning system playful and enjoyable to inter-act with is crucial for attracting more users to the m-learning system. The users targeted by Wang et al and the current study are very similar in age and educational level to those in the current study, and the use of mHealth apps, like mLearning apps, is discretionary. This suggests that the hedonic motivation factor will have a positive correlation with intention to use and continuation to use a mobile fitness app.

*b) Price value*

In a consumer context, it is the individual rather than the organisation who bears the cost of a new piece of technology. Venkatesh et al, 2012, define price value as consumers' cognitive trade-off between the perceived benefits of the applications and the monetary cost for using them. They suggest that "adding a construct related to price/ cost will complement UTAUT's existing resource considerations that focus only on time and effort" (ibid). In this study, price/value motivation will be understood as an individual's belief that the cost of buying and using an mHealth app (and/or service) will be worth the investment.

*c) Habit*

Venkatesh and others have "challenged the role of behavioral intention as the key predictor of technology use and introduced a new theoretical construct, habit, as another critical predictor of technology use" (Venkatesh et al, 2012, p.158). Habit is closely related to the notion of "experience," i.e. the passage of time from starting to use a technology. It has similarities to Rogers' idea of "trialability." Venkatesh et al prefer to see habit as a self-reported perception of a kind of automaticity in use (Venkatesh et al, p. 161). The authors claim that "[i]ntegrating habit into UTAUT will complement the theory's focus on intentionality as the overarching mechanism and key driver of behaviour" (ibid). In this study, habit motivation will be understood as an individual's belief that using an mHealth app will become automatic. In fact, habit formation is an important perspective in HCI for behaviour change, though this theoretically driven aspect is often overlooked in commercial app design (Stawarz et al,

2015). The ability of an app to encourage a user to turn a health-related behaviour, e.g. not smoking, into an automated habit, will reinforce the app's efficacy.

Individual differences (age, gender and experience) are theorised to moderate the relationship of the effects between these consumer factors, behavioural intention and technology use.

> First, the impact of hedonic motivation on behavioral intention is moderated by age, gender, and experience. Second, the effect of price value on behavioral intention is moderated by age and gender. Finally, habit has both direct and mediated effects on technology use, and these effects are moderated by individual differences. (Venkatesh et al, 2012, p. 174)

The model, as explained earlier, adds the three "consumer" factors to the four "basic" factors of Performance Expectancy, Effort Expectancy, Social Influence and Facilitating Conditions.

*a) Performance Expectancy*

Many studies have found a strong correlation between performance expectancy and intention to use technology. In this study performance expectancy refers to the health benefits that the consumer expects to obtain from using fitness applications. The theoretical background of performance expectancy of fitness apps also comes from the Health Belief Model (HBM) as it suggests that "health-related behavior is influenced by a person's perception of the threat posed by a health problem and by the value associated with his/her action to reduce that threat" (Canbulat & Uzun, 2008, p. 148). This theory has been used by many researchers to predict the consumer's health behaviour. For instance, a recent study by Abolfotouh et al (2012) of Saudi women and their attitudes to breast self-examination (BSE), found that "according to the HBM scale, a woman who perceives that she is susceptible to breast cancer and that breast cancer is a serious disease would be more likely to perform regular breast examinations. Similarly, a woman who perceives more benefits of and fewer barriers to BSE would be more likely to practice BSE" (p. 1164). Hence, in this study, it would be assumed that if a consumer accepts the health benefits of

using an mHealth app, then the correlation with intention to use and continuation to use the fitness app is likely to be positive.

*b) Effort Expectancy*

This is the “degree of ease associated with consumers’ use of technology” (Venkatesh et al, 2012, p. 159), derived from the elements of perceived ease of use, complexity and usability in previous models. In the context of this study, effort expectancy refers to the ease of using fitness apps, which could relate simply to the cognitive aspects of the usability of the interface or other activity required by the app, e.g. noting and entering food choices. Many studies have shown a positive correlation between effort expectancy and the initial and continuation usage. For instance, Macedo (2017) found that, “consistent with previous UTAUT assumptions …effort expectancy (H2) and social influence (H3), although presenting smaller coefficient weights, have a significant effect on intention. As Czaja et al. (2006) demonstrated, older adults are usually receptive to the adoption of ICTs as long as they perceive them as useful and feel that they are easy to use” Macedo, p. 945. In this study, it would be assumed that if a consumer initially perceives an mHealth app as promising ease of use, the correlation with intention to use the fitness app is likely to be positive. If actual ease of use is experienced, then there should be a correlation with continued intention to use.

*c) Social Influence*

Social influence is defined as “the degree to which an individual perceives that important others believe he or she should use the new system” (Venkatesh et al., 2003, p. 451). Many studies, inside and outside the health area, have shown social influence to be a significant predictor for adoption and acceptance of technology. For example, Macedo (2017) explains that in the context of older people’s acceptance of the Internet, Social influence relates to the their “perceptions of the importance attributed to using a computer by those who are significant in their lives, like close relatives and friends or simply people whose opinions are valued”. Macedo refers to Oh and Yoon (2014) who found a strong path between social influence and intention. Accordingly, their study evidenced that users subject to a high level of social influence (e.g. opinions of important

persons or immediate social environments) were likely to use the Internet. Social influence is a complex construct (Venkatesh et al., 2003) and is one of the factors slightly modified in this study, which attempts to distinguish between influence from friends and family (on the grounds that KSA is a highly collectivist society, where family, friends, neighbours and so on have a very strong influence on an individual's behaviour) and influence from the medical profession on the other (on the grounds that the study participants, mainly young and healthy, were unlikely to be subject to heavy influence from the medical profession). In other words, in this study, we would assume a stronger positive correlation between friend-based social influence and intention to use, than influence from the medical profession.

*d) Facilitating conditions*

Facilitating conditions refer to "consumers' perceptions of the resources and support available to perform a behaviour" (Venkatesh et al, 2012), p. 159. While performance expectancy, effort expectancy, and social influence are assumed to influence intention to use a technology, in the 2003 model of UTAUT, facilitating conditions (along with intention to use) directly determine technology use. However, in UTAUT2 facilitating conditions are theorised in UTAUT2 (2012) as having both a direct effect on use and an indirect effect through behavioural intention. Like Social Influence, Facilitating Conditions may be complex, and to some extent overlap with perceived effort expectancy. For instance, a consumer who is thinking about buying an interactive television set may need to set up the facilitating conditions by buying a set-top box but may decide that understanding the different models and services is too complex to bother (effort expectancy). Macedo's 2017 study found that facilitating conditions correlated strongly both intended and actual use, "suggesting that for older adults, the intention to use ICT is reinforced when they feel familiar with the technology and are equipped with the resources and the knowledge required for its use". Macedo argues that Intention is influenced by perceived behavioural control, which shares aspects of facilitating conditions (Nagle & Schmidt, 2012). "This implies that a sense of control over aspects related to technology usage is important to trigger behavioural intention" (Macedo, p.938). Perceived user control is also an important component of usability or ease of

use (Nielsen, 1995), again inviting the comparison with effort expectancy, based on perceived ease of use. In this study, facilitating conditions refers to the readiness to hand of technical resources such as a smartphone, broadband supply and so on.

### 2.4.3. Other factors related to mHealth usage and acceptance

UTAUT2 has been available since 2012 and is now well used and accepted. However, health mobile applications are a new field and other factors than those in UTAUT2 may be relevant to acceptance. Of course introducing new potential factors does threaten the parsimony of UTAUT2 (which is already much more complex than TAM), but here we identify three extra items that have been investigated in the present study.

#### *Trust in the mHealth apps*

Studies over the last 15 years have indicated that trust is a strong factor that effects the consumer's adoption of technology (Dahlberg et al, 2003; Srivastava et al, 2010; Abu-Shanab, 2014). This is particularly acute in apps dealing in some way with money, such as mCommerce, ticketing, mobile banking and so on. For instance, Dahlberg et al's participants generated a long list of potential security risks:

1. **Unauthorized use**: the interviewees were concerned that someone would be able to pay with the mobile phone were the device lost or stolen.
2. **Transaction errors**: the interviewees perceived errors in payment transactions as a potential risk…
3. **Lack of transaction record and documentation:** the interviewees perceived it difficult to follow up the amount of payments made with a mobile phone since they did not get any receipt or other efficient means to keep track of the payments. Also, without a receipt a payer has no proof of the payment transaction.
4. **Vagueness of the transaction:** the interviewees felt lack of control when paying with a mobile phone. They were unsure of whether the payment had taken place or not and whether the payment had been charged or not…
5. **Privacy issues**: some of the respondents were unwilling to trust their personal information with the payment service providers. They were concerned that their

purchases would be tracked or that they would begin to receive a lot of advertisements.

6. **Device and mobile network reliability**: the mobile device and network were considered unreliable for payments. The device's battery could discharge or the network connection could fail in the middle of a payment transaction.

Many of these concerns are particular to apps processing financial transactions and will not apply to mhealth apps. Concerns over privacy, however, may be relevant and are considered in the next section. However, trust, understood differently from simply perceived lack of financial risk, may still be relevant to adoption and continued use of mHealth apps, if we understand it as a perception of high quality and potential effectiveness. The content and functionality of health-related smartphone apps is unregulated and frequently completely unvalidated, which, together with the high number of apps available, make it difficult for consumers to be sure they have bought a good quality health app.

Following Akter et al (2012), “trust” in mobile health apps will be understood as “the user’s judgment about the overall excellence or superiority of the mHealth service platform…If the system cannot be trusted to guarantee a threshold level of quality, it will remain underutilized, be bypassed, or used as a measure of last resort” (p. 30). The importance of quality perceptions and consumer trust has been implied in numerous health studies because of their strong effects on user satisfaction and continuance intentions (Kaplan 2006; Ahuwalia & Varshney 2009). Closer to the current study, Schnall et al (2015) integrated trust (and risk) as variables in their study of the “behavioral intention to use a mobile application for meeting the healthcare needs of persons living with HIV (PLWH)” (p.476). For Schnall et al, trust is “the belief that the other party will behave responsibly and will not attempt to exploit the vulnerabilities of the user (Pavlou, 2003). There are two kinds of trust: 1) party trust - trust in the benevolence and credibility of a particular party; and 2) control trust - trust in the integrity of the transaction medium. The importance of trust is heightened when there is a high degree of uncertainty which can happen in the case of HIT when users don’t understand where their information is being stored or how it is being transmitted” (p.468).

As Schnall et al indicate, trust is a complex concept and does not stand alone. It is “related to perceived usefulness because users may not be certain that outcomes may be achieved unless there is confidence in the entities behind the…system. Trust is related to perceived ease of use because it reduces the efforts that would otherwise be necessary to monitor the proper functioning of the system. Trust is also related to perceived risk as a higher level of trust in an on-line entity reduces the perception of risk during the interaction”. Again in an mhealth context, Guo et al (2016) see trust as a “multi-faceted concept that incorporates competence (TBC), integrity (TBI), and benevolence (TBB), where benevolence is perceived as providers caring about their consumers’ welfare, and acting in the consumers’ interests. By the same token, competence refers to the providers’ ability to perform effectively (by meeting consumers’ needs) and integrity refers to providers’ honesty in fulfilling their promises”. We therefore adopt a similar definition of trust that distinguishes it from privacy fears, but which encompasses quality concerns and also trust in the promoters of the app.

### *Privacy and Risks of using mHealth apps:*

It has been found that the privacy of data is an important factor that effects the consumer adoption of mHealth apps. Plachkinova et al (2015) developed a taxonomy aiming to raise awareness of the problem of apps collecting and managing health data from mobile users, suggesting that “the lack of regulation on the mobile market poses a potential threat to the privacy and security” (p. 3195)

Individual monitoring and tracking data from a health may include not only health-related data but also general data about the consumer such as age, gender, mobile number and location. This data could be shared with other parties without users’ awareness or consent. Schnell et al (2015) found that “perceived risk was an underlying theme throughout our nine focus group sessions. Participants were concerned over where their data was being stored and who would have access to their data. Their concerns included trust in the institutions that collect, store, or transmit their data as well as general apprehension about data transfer using the internet network and technological devices which are continually under development” (p.470). Thus, trust and

privacy are again closely related. Furthermore, perceived privacy risks of using mHealth apps may result from a lack of transparency between the app provider and the user. As a result, consumers may relate the health advantages acquired from using mHealth apps with privacy loss, bringing about more perceived privacy risks. Divulging personal data to a provider may, of course, have positive results, in that applications can then send personalised feedback and other messages. Guo et al (2016), following Awad and Krishnan (2006), refer to this as the "privacy–personalization paradox:" "Consumers must share their health information (e.g., health status, preferences, living habits, or phone numbers) to service providers to utilize personalized services (e.g., personalized care which circumvents geographical barriers, time-saving services, and consulting services). However, this results in privacy concerns relating to the collection of consumer information: an apparent technological paradox." Guo et al found in their study of mhealth adoption intention that privacy worries were mediated by trust and that older consumers were less likely to worry about privacy than younger people.

In this study, it can be argued that consumers who perceive fewer privacy risks in using fitness apps are more likely to intend to use and continue to use these apps.

### *Valuation of health*

A final variable is what we refer to as "valuation of health" or attaching importance to one's own state of health and feeling that one can/should take care of it. Described here in the context of HIV prevention, the influential psychologically-driven Health Belief Model (Glanz et al, 2002) is "based on the understanding that a person will take a health-related action (i.e. use condoms) if that person:

- feels that a negative health condition (i.e. HIV) can be avoided,
- has a positive expectation that by taking a recommended action, he/she will avoid a negative health condition (i.e. using condoms will be effective at preventing HIV), and
- believes that he/she can successfully take a recommended health action (i.e. he/she can use condoms comfortably and with confidence)" (University of Twente, 2017).

“ HBM believes that a person makes a decision on whether or not to take a health-related action based on his/her evaluations on the perceived threat of not taking the action and the net benefits of taking the action. Specifically, perceived threat is assessed according to perceived susceptibility (i.e., one’s opinion of chances of getting a condition) and perceived severity (i.e., one’s opinion of how serious a condition and its consequences are). Net benefits are calculated based on perceived benefits (i.e., one’s belief in the efficacy of the advised action to solve the threat) and perceived barriers (i.e., one’s opinion of the tangible and psychological costs of the advised action)” Sun et al, 2013, p. 187.

Although usually employed with existing conditions, it can be applied to preventative health behaviours, such as those encouraged by mobile health fitness/diet apps discussed in this study. A healthy life style indicates the achievement and maintenance of one’s physical well-being in order to prevent chronic diseases. In this study, it can be argued the consumers who believe that:

- obesity can be avoided
- adopting a healthy lifestyle in terms of diet and exercise will avoid obesity
- the mobile health app will help/enable them to lead a healthy lifestyle

will be more likely to intend using a fitness app. Those who think obesity is inevitable and that they have no effective tools to avoid it, will be less likely to adopt the technology, and, if they begin to use such an app but find it ineffective, will be less likely to continue its use.

### 2.4.4 Implications

We have seen in this overview of technology acceptance models that the acceptance of mobile fitness apps is the kind of topic that lends itself well to treatment from the technology acceptance perspective. As a consumer purchase, the fitness app lends itself to analysis using the extended consumer-oriented UTAUT model. Most recent literature points to the importance as trust or risk avoidance as an additional factor in user acceptance of mobile apps, included those related to health: trust will therefore be integrated into the model.

In addition, a user's beliefs about their own role in preventing and treating disease, based on the Health Belief Model, can also impact their attitude to such apps. This has led us to formulate the idea of "valuation of health" and to integrate it into the UTAUT model used in this research.

## 2.5 Cross-cultural aspects of technology use

This project is concerned with the attitudes of people from a specific society, the Kingdom of Saudi Arabia. It may be that some of the attitudes uncovered may reflect aspects of the general cultural make-up of the country. The most influential model of national cultural attitudes is that developed over several decades by Gert Hofstede, whose conceptualisation of cultural differences has been widely applied. In this section, we give a brief overview of Hofstede's model and show how it has been used in a number of IT adoption studies. Hofstede developed his original model based on the results of a worldwide survey of employee values by IBM between 1967 and 1973. It has since been refined and extended. "The original theory proposed four dimensions along which cultural values could be analysed: individualism-collectivism; uncertainty avoidance; power distance (strength of social hierarchy) and masculinity-femininity (task orientation versus person-orientation). He later added a fifth dimension, long-term orientation, to cover aspects of values not discussed in the original paradigm (Hofstede, 2017)

Table 2.1. Measures of cultural dimensions

| **Hofstede's dimension** | **Definition** |
|---|---|
| Uncertainty avoidance (UA) | Focuses on the level of tolerance for uncertainty and ambiguity within the society. High UA indicates a structured, rule-oriented society that institutes rules, regulations, and controls in order to reduce the amount of uncertainty |
| Power distance (PD) | Focuses on the degree of equality, or inequality, between people in the country's society. High PD indicates that inequalities of power and wealth are accepted practices and have been allowed to grow |

| Hofstede's dimension | Definition |
|---|---|
| Masculinity (MAS) | Masculinity measures the degree to which “masculine” values like assertiveness, performance, success and competition prevail over “feminine” values like the quality of life, maintaining warm personal relationships, service, caring, and solidarity |
| Individualism (IDV) | Focuses on the degree the society reinforces individual or collective achievement and interpersonal relationships. Low IDV typifies societies of a more collectivist nature with close ties between individuals. These cultures reinforce collectives where everyone takes responsibility for fellow members of their group |
| Long-term orientation or confucian dynamism (LTO) | Cultures typified by a long-term orientation are oriented towards future rewards, in particular perseverance and thrift, while a short-term orientation is characterized by values relating to both the past and present, in particular, the respect for tradition, preservation of “face” and the fulfillment of social obligations |

In 2010, Hofstede added a sixth dimension, indulgence versus self-restraint” (Hofstede, 2017). This dimension is essentially a measure of happiness, i.e. whether or not simple joys are fulfilled. Indulgence is defined as “a society that allows relatively free gratification of basic and natural human desires related to enjoying life and having fun.” Its counterpart is defined as “a society that controls gratification of needs and regulates it by means of strict social norms.”

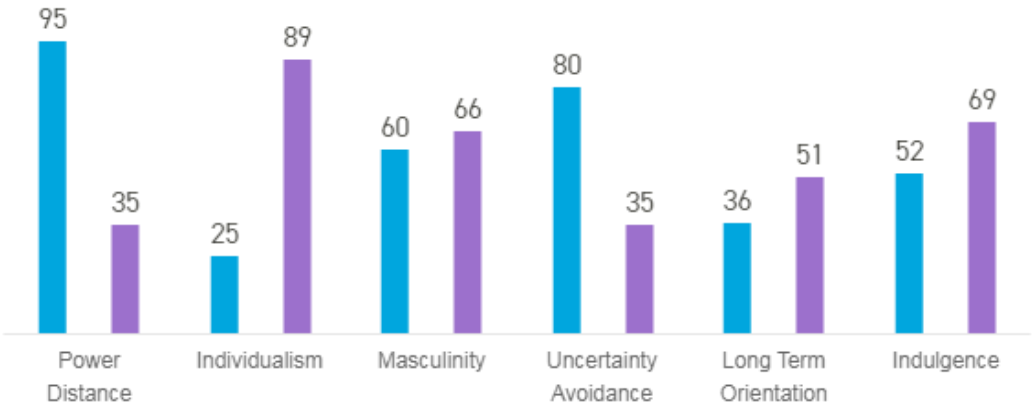


Table 2.2 shows the country scores of these dimensions for Saudi Arabia (blue) and the United Kingdom (purple). Saudi Arabia ranks much higher than the UK in power distance and uncertainty avoidance. The two countries are similar in masculinity. Saudi Arabia is much lower in individualism, and slightly lower in long-term orientation and indulgence.

Hofstede's cultural dimensions and scores are an attractive and relatively simple way to conceptualise national cultural difference. In this sense, they may be seen as rather too seductive. Certainly Hofstede has attracted serious critiques, usefully summarised by Jones (2007). The model can be criticised on a range of grounds (based on Jones, 2007):

> *Methodology:* "a survey is not an appropriate instrument for accurately determining and measuring cultural disparity. This is especially apparent when the variable being measured is a value which culturally sensitive and subjective (Schwartz 1999).
>
> *Cultural Homogeneity:* This criticism is perhaps the most popular. Hofstede's study assumes the domestic population is a homogenous whole. However most nations are groups of ethnic units… On the other hand Hofstede tends to ignore the importance of community, and the variations of the community influences.
>
> *National Divisions:* Nations are not the proper units of analysis as cultures are not necessarily bounded by borders.
>
> *Political Influences:* The outcomes, particularly those pertaining to Masculinity and Uncertainty Avoidance, may have been sensitive to the timing of the survey. Europe was in the midst of the cold war and was still haunted by vivid memories of World War Two, with communist insurgence in Asia, Africa and Europe. As a result of the political instabilities of the time, the sample lacks data from socialist countries, as well as from the less affluent Third World Countries.
>
> *One Company Approach:* A study fixated on only one company cannot possibly provide information on the entire cultural system of a country
>
> *Out-dated:* Some researchers have claimed that the study is too old to be of any modern value, particularly with today's rapidly changing global environments, internationalisation and convergence.
>
> *Too Few Dimensions:* Four or five dimensions do not give sufficient information about cultural differences. Hofstede agrees, he believes additional dimensions should continue to be added to his original work (Hofstede 1998, 481).

While many aspects of the critiques seem very apt, Hofstede has defended his work on each point, and the model continues to be the default resource when describing cultural difference. In the absence of a more powerful model, we will refer to Hoftsede in discussing our results to see whether the cognitive dimension measure explain any of the results from the UTAUT2 investigation.

A number of studies have used Hofstede's model as a framework in the technology acceptance area to complement UTAUT and other approaches. A wide-ranging study carried out by Erumban et al (2006) explored the general question of whether adoption of IT was linked to cultural factors at a national level, using Hofstede's dimensions. The effect of culture on ICT adoption was explored by applying two different measures of ICT adoption, namely "the average share of ICT spending in GDP across 42 countries, and computer per capita across 49 countries. The results suggested that the national culture and the ICT adoption rate of a country are closely related. It appears that most of the Hofstede dimensions are important in influencing ICT adoption… In particular, the power distance and the uncertainty avoidance dimensions seem to be the most important ones" (Erumban et al. 2006, p. 302).

Ozbilen (2017), working at the level of the company rather than the individual, used Hofstede's cultural framework to measure national cultural differences. "The data of new technology adoption at firm-level on a country basis was obtained from The Global Information Technology Report, 2016" and analysed against Hofstede's cultural dimension scores. "The results reveal that power distance, uncertainty avoidance, individualism and long-term orientation dimensions have a satisfactory influence on the adoption of new technology at firm-level; however, the dimension of masculinity does not affect it" (Ozbilen, 2017). In particular, long-term orientation appeared to be a strong positive factor in adoption and use.

Baptista and Oliveira (2015) actually integrated several of Hofstede's dimensions into a UTAUT2-based model to study the take-up of mobile banking in Mozambique, using the cultural dimensions as moderating factors. They found that if the UTAUT constructs, performance expectancy, hedonic

motivation, and habit were the strongest antecedents of behaviour intention. “Collectivism, uncertainty avoidance, short term, and power distance were found to be the most significant cultural moderators” (p. 430). They found that this combined approach was a powerful way to understand the main impacts of local culture in the mobile banking acceptance and use. “By incorporating cultural moderators in the proposed research model, we also added stronger determinants to predict intention to use mobile banking, and thus provided more predictive power to existing UTAUT2” (p. 430).

Al-Gahtani et al (2007) drew on Hofstede's dimensions to describe select cultural differences between Saudi Arabia and the US and to discuss cultural implications of IT user acceptance. Using a survey sample collected from 722 knowledge workers using desktop computer applications on a voluntary basis in Saudi Arabia, they examined the relative power of a modified version of UTAUT in determining ‘intention to use’ and ‘usage behavior’ (p. 681) and found that subjective norm (social influence) positively influenced intention to use, but negatively interacted with increasing levels of age and experience on intention. These results indicate that, among Saudi users, subjective norm positively influences intention, but, as expected, this influence was diminished by both increasing age, and increasing years of experience using computers” (Al-Ghatani, 2007).This was as predicted by the researchers on the basis of the high Saudi score for power distance.

It may be rather premature to incorporate cognitive dimensions directly into the UTAUT2 model. However, as discussed above in Chapter One, cultural characteristics such as a low tendency to individualism, a high power distance and a high uncertainty avoidance may well go some way to explain any results found using the UTAUT2 model.

## 2.6 Research Questions

The overall aim of this research study is to determine the factors that affect user acceptance and adoption of mHealth applications to support the health needs of overweight and obese people in Saudi Arabia, or those trying to maintain a healthy weight. The UTAUT2 model provides a structured way of approaching

this aim, by suggesting factors that may figure in responses to the following high level questions:

1. What drives consumers' initial usage intention, in Saudi Arabia, with regard to smartphone fitness apps?
2. What are the barriers to consumers' initial intention to adopt these technologies?
3. Once using the applications, what influences a consumer's decision to continue to use them or not?

These are our major research questions. In addition, the project provides an opportunity to reflect on methodological issues, raising two further questions:

4. Does the UTAUT2 model provide an appropriate model or tool for investigating IT adoption in the Saudi context?
5. Is a model of cross-cultural characteristics useful in interpreting consumer attitudes in this context?

## 2.7 Summary

In this chapter, we reviewed the literature on disciplines relating to acceptance of mHealth in Saudi Arabia. The review showed that public health has now to take into account eHealth, and more specifically mHealth technologies, which address a range of conditions including overweight and obesity. Initial adoption and continued use of such applications have been studied using a range of approaches, one of which is the technology acceptance model, of which the most relevant version is UTAUT2. We discussed the variables of UTAUT2 and proposed three extra variables, trust, privacy concerns and valuation of health.

# Chapter Three: Research Design

The aim of this chapter is to explore the range of possible research methods and techniques that could be used to answer the questions identified in Chapter Two as offering insights into the general issue of the potential for fitness apps in combatting obesity by Saudi users. Given any topic in Information Systems, there will be a range of possible methods and techniques that can be used to collect and analyse data, leading to appropriate conclusions and hence new knowledge. The research design of an investigation is the outcome of deciding which approaches to take for the given topic, and this in turn will depend on high level, sometimes implicit, ideas about the nature of knowledge. In this chapter we outline the way through the multiplicity of choices leading to our research design, from high level research philosophies to more concrete and practical issues of questionnaire design, sampling and so on, providing a base to consider the actual research activity that unfolded, which is described in Chapter Four.

## 3.1 Ontology and Epistemology

The philosophy of knowledge has an extremely long and complex history, which is beyond the scope of this thesis. However, a useful summary is supplied by Easterby-Smith, Thorpe and Jackson (2012, p. 12), who identify four main aspects of research design, which are different but closely related, and which need to be in alignment to create a viable research design. These are:

- **Ontology.** How the researcher views the world and the assumptions they make about the nature of the world and of reality.
- **Epistemology.** The assumptions that a researcher makes about the best way of investigating the world and about reality.
- **Methodology.** The way that a researcher groups together research techniques to make a coherent picture.
- **Methods and techniques**. What the researcher actually does in order to collect data and carry out an investigation.

Before choosing specific methods, it is helpful to reflect on a researcher's (or a discipline's) basic philosophy (ontology and epistemology), before selecting, combining and setting in motion specific methods (methodology and methods).

| Ontology | Realism | Internal Realism | Relativism | Nominalism |
|---|---|---|---|---|
| Summary | The world is 'real', and science proceeds by examining and observing it | The world is real, but it is almost impossible to examine it directly | Scientific laws are basically created by people to fit their view of reality | Reality is entirely created by people, and there is no external 'truth' |
| Truth | There is a single truth | Truth exists, but is obscure | There are many truths | There is no truth |
| Facts | Facts exist, and can be revealed through experiments | Facts are concrete, but cannot always be revealed | Facts depend on the viewpoint of the observer | Facts are all human creations |

Table 3.1 Ontology (Easterby-Smith, Thorpe and Jackson (2012, p. 12)

The underlying philosophy, which is roughly equivalent to Kuhn's notion of a paradigm (Kuhn, 1962), strongly affects ideas about the nature of knowledge (epistemology). For the positivist, according to (Chilisa & Kawulich, 2012), the nature of knowledge is inherent in the natural science paradigm. In other words, positivists view knowledge as those statements of belief or fact that can be tested empirically, can be confirmed and verified or disconfirmed, and are stable and generalisable. Relativistic researchers, however, believe that knowledge is subjective, because it is socially constructed and mind dependent. Truth lies within the human experience. Statements on what is true or false are, therefore, culture-bound, historically and context dependent, although some may be universal. This distinction may also affect the extent to which others may be willing to rely on knowledge emanating from these different traditions, with scientific knowledge held up as the aspiration and more human-based knowledge less highly valued. We will return to this point in our discussion of UTAUT and similar models (3.2).

If ontology aligns with epistemology, it also exerts a powerful influence on the choice of research methods and techniques. For example, a realist (or positivist) will attempt to "uncover the truth", typically using a quantitative

methods, whereas a relativist will be interested in exploring different people's ideas of the truth, using interviews and other qualitative approaches. As Chilisa and Kawulich put it, "[p]articular paradigms may be associated with certain methodologies. For example, a positivistic paradigm typically assumes a quantitative methodology, while a constructivist or interpretative paradigm typically utilizes a qualitative methodology (Chilisa & Kawulich, 2012). This is not a set linkage: there are instances in which one may pursue an interpretative study using a quantitative methodology (Chilisa & Kawulich, 2012). Again, this is relevant to our discussion of UTAUT. Table 3.2 sets out some of the linkages discussed above:

| | **Positivist paradigm** | **Interpretivist paradigm** |
|---|---|---|
| Basic beliefs | The world is external and objective. The observer is independent. Science is value free | The world is socially constructed and subjective. Observer is part of what is observed. Science is driven by human interest |
| Researcher should | Focus on facts. Look for causality and fundamental laws. Reduce phenomena to simplest elements. Formulate hypotheses and then test them | Focus on meanings. Try to understand what is happening. Look at totality of each situation. Develop ideas through induction from data |
| Preferred methods include | Operationalising concepts so they can be measured. Taking large samples | Using multiple methods to establish different views. Small samples investigated in depth or over time |

Table 3.2 Research philosophies and methods (Easterby-Smith, Thorpe and Jackson (2012, p. 12)

In terms of disciplines, while some, such as the natural and physical sciences, will be heavily tilted towards a realist approach, information systems, lying in some ways at the intersection between computer science and business studies,

is studied in a multiplicity of ways, depending on the specific topic. When we turn to the topic of mHealth, a positivistic paradigm might, for instance, produce a study of the actual penetration of mHealth products, perhaps with a before-and-after comparison of the metrics of incidence of a particular disease or other medical problem, in an attempt to relate cause to effect. This will surely be a popular and fruitful research path in future years.

However, at this stage in the evolution of mHealth, adoption is a critical issue, which we believe is best studied in the context of an interpretivist (or relativist) paradigm, i.e. one that is concerned with people's opinions and perceptions. However, the data that can be produced or uncovered using methods most closely aligned to an interpretivist approach, for instance, case studies, biographies, grounded theory or ethnographies, are rich, complex and notoriously difficult to transform into clear results. In the next section we discuss the methodology used in this study, which attempts to combine a search for human views and opinions with a quantitative approach more natural to a positivistic stance.

## 3.2 Methodology

In this section, we discuss a number of decisions made about the project, given the general decision to pursue the theme of technology adoption, using the six elements identified by Sekaran (2003), together with an extra factor, "availability of information."

- Purpose of the study
- Study setting
- Time horizon
- Unit of analysis
- Extent of researcher interference
- (Availability of information)
- Type of investigation

All these decisions were subject to the general constraints of a PhD project, e.g. single researcher, three-four year time limit and so on. They were also subject

to funding requirements, hence a preference for a Saudi setting. Some decisions were unproblematic, while others will be discussed in more detail.

### 3.2.1 Purpose of the study

The purpose of the study, and its high-level aim, is as defined in Chapter One:

> The aim of this research study is to determine the factors that affect user acceptance and adoption of mHealth applications to support the health needs of overweight and obese people in Saudi Arabia, or those trying to maintain a healthy weight. In particular, we explore the consumers' initial usage intention and consumers' continuous usage intention for fitness apps.

The justification for the investigation is explored in Section 1.1 Statement of the Problem and will not be repeated here.

### 3.2.2 Study Setting

As the project is funded by the Cultural Bureau of the Kingdom of Saudi Arabia and the researcher is of Saudi nationality, with access to Saudi subjects, the setting of the study in Saudi Arabia is practical and feasible. As explained in Section 1.1, the health problems caused by obesity are particularly acute in the country, making it a very appropriate setting.

### 3.2.3 Time Horizon

As the project is a funded PhD programme, a time limit of three years in total applies. This limits data collection and analysis to approximately 12 months, sandwiched by design and writing up stages. Given publishing constraints for the literature consulted, the study will reflect a situation approximately two years before time of writing, which is a drawback given the fast-moving nature of mHealth developments.

### 3.2.4 Unit of analysis

The unit of analysis is the major entity that is being analysed in a study. It is the "what" or "who" that is being studied. Typical units of analysis include individuals (most common), groups, social organisations and social artefacts (adapted from Wikipedia). As the data sought in the study consists of the opinions and attitudes of potential app users, the unit of analysis is the individual, specifically male or female Saudi mobile phone users from the general population. It was

not thought necessary to restrict the population further by concentrating on sub-groups, e.g. females, students, city dwellers and so on, so the study population is inclusive. We have chosen to concentrate on young (= under 35 years old) Saudis, as they are the most enthusiastic adopters of mobile phones and therefore the most likely adopters of mHealth solutions. We discuss the sample more fully below in 3.3.

### 3.2.5 Extent of researcher interference

Some research methods used in Information Systems research, particularly ethnographic and action research approaches, involve a tight integration of the researcher into the setting that s/he is studying. With other methods, e.g. an online questionnaire, the researcher is relatively distant and even anonymous. This spectrum tends to correspond to numbers of human subjects who can be included in a study: an “embedded” observer can investigate only a small number of subjects, while a more distant observer can gather a information about a large number of subjects. In this case, as we used a model that needed large numbers of subjects to generate meaningful results, the researcher remained at a distance, except when undertaking the focus group (see below).

### 3.2.6 Availability of information

The choice of methodology can depend on the extent to which the topic has already been studied. It is common to distinguish between exploratory and confirmatory research projects. Butler (2014) gives a clear explanation:

> Exploratory research is the stage of the research process that aims at connecting ideas as to unveil the “why”s of potential cause/effect relationships. This occurs when researchers get started at understanding what they are actually “observing” when in the process of building cause/effect models. Confirmatory research (a.k.a. hypothesis testing) is where researchers have a pretty good idea of what's going on. That is, researcher has a theory (or several theories), and the objective is to find out if the theory is supported by the facts.

A decision on whether an exploratory or confirmatory study is appropriate depends in part on the extent to which the issue is already well understood. If the topic is already well explored, a confirmatory study can be designed, to test

realistic hypotheses. If there is little information available, it will be necessary to carry out an exploratory study.

In this case, an explanatory study might be justified, as there is little direct evidence on adoption of mHealth apps in Saudi Arabia. However, the general topic of technology adoption *has* been well studied, beginning with Rogers' Diffusion of Innovation (1962) and other work cited in 2.4 Acceptance of Innovations. This means that the methods, models, units of analysis and other aspects of Technology Acceptance research are available for application in this study. Therefore the study is exploratory as regards the setting, but confirmatory in the sense that it tests the appropriateness of the technology acceptance model in this setting.

### 3.2.7 Type of investigation

The focus of the study is on technology acceptance, where, as shown in the literature review, the preferred approach is the application of a general TAM-inspired model, to a particular case. Less structured approaches may also be fruitful, e.g. those using smaller scale social science methods, but, given the existence of a large body of prior research on technology acceptance it was decided to apply a model developed in this work to the specific case of Saudi Arabia.

#### *3.2.7.1 Using a Model*

This use of a previous model has both advantages and disadvantages. On one hand, a pre-existing model provides a framework of factors to structure an investigation, together with a method and possibly a range of results from other similar studies. This gives a rigour to the study that could be absent if the only factors studied were those particular to a single study. This in turn may make the results easier to compare with others and also instill confidence in their reliability, as mentioned above in 3.1.

On the other hand, using established factors may serve to constrain the investigation to already-trodden paths and make a researcher reluctant to consider other factors on the grounds that they do not fit the model. It is therefore important that researchers feel able to test the validity of potential new factors. This has in fact been a feature of many of the projects described in

Section 2.4. In this study, we used a focus group study, in conjunction with the background literature review, to identify factors that might not have been part of the general model.

#### *3.2.7.2 Model selection*

The selection of the model emerged from the literature review, which traces the development of TAM-inspired models from their beginnings as strictly concerned with business IT system acceptance, to the present day, where consumer IT has become the focus. In the literature review, we described a number of models, any of which could have been selected for this study.

Rogers' original Diffusion of Innovation is still a very attractive model, covering multiple aspects of the acceptance process for individual products. Adopting this model would produce a rich set of data around a specific technology. For instance, we could apply the DoI model to the use of an e-learning platform in a specific university or the take-up of online appointments in a specific doctor's surgery. This is because Rogers does not concentrate simply on the adoption decision, but on the many other elements involved in diffusion, such as knowledge, persuasion and so on (see above p. 60). As we did not have a specific innovation in mind, but rather a *class* of innovative technologies, this case study approach would not be a good fit at this stage. However, if a single app were to emerge, a multi-perspective study of its diffusion, including the role of change agents, the social system, communication channels and so on, would be extremely interesting, generating qualitative rather than quantitative data. This could take the form of either a retrospective study on an attempted innovation, combining empirical with survey-based evidence, or a more active approach in line with Ellsworth's view cited above in Chapter Two, that "[p]ractitioners are likely to find this perspective of the greatest use if they are engaged in the actual development of the innovation or if they are deciding whether (or how) to adapt the innovation to meet local requirements…Rogers' framework can be useful in determining how it is to be presented to its intended adopters" (Elsworth, 2000, p.40).

As noted in Chapter Two, the "decision" stage of the innovation adoption process is the most difficult for which to acquire empirical evidence (Rogers, p.

83), and a number of models have been developed to explain it. Davis' Technology Acceptance Model (TAM) can be seen as the parent of more recent models and as such is still very influential. TAM is still used by researchers and could also have been used as a framework for the present study. However, TAM has a number of constraints. While its simplicity and parsimonious structure are attractive, consisting of two factors, Perceived Usefulness and Perceived Ease of Use, the literature review and introductory study of obesity in KSA suggests that factors other than this may be at work. In particular, we would like to explore the group vs individual distinction suggested by Hofstede's analysis of KSA society. In addition, several studies have found that PEOU is a negligible factor in adoption decisions. Moreover, in the case of a general study of mHealth apps such as the present one, questions about ease of use would tend to be quite unrealistic, given that we are not concentrating on a single, known interface.

The UTAUT2 model selected for use here has two major strengths over TAM. Firstly, as UTAUT and then UTAUT2, it integrates the plethora of factors identified in a wide range of previous model-based studies into a single model that was found to outperform each of the individual models (Venkatesh et al, 2003). Secondly, UTAUT2 includes the user and their experience as factors in the model, making it more suitable for product or service-oriented research, where the consumer has agency. The traditional TAM models were more often used to adoption of technologies in the workplace, where an individual may not have a free will to say no to such technologies.

The TAM approach, including UTAUT, has been the target of criticism, particularly from Benbasat and Barki, who claim that TAM "has diverted researchers' attention away from other important research issues and has created an illusion of progress in knowledge accumulation. Furthermore, the independent attempts by several researchers to expand TAM in order to adapt it to the constantly changing IT environments has led to a state of theoretical chaos and confusion" (2007). There seems to be some justification for these critiques, particularly the question of parsimonious models, as many research projects have added their own factors to the model in a rather haphazard way, which we try to avoid in the current study.

As noted in Chapter Two, TAM does rely on self-reports of intended and actual use, and in some contexts, a more empirical approach might be preferable. It is also the case that the TAM approach does tend to ignore wider social issues that have an impact on technology adoption, the effects of technology use and its social consequences. These are issues that, in the case of mHealth adoption, could very fruitfully be pursued in future studies using other approaches.

TAM does, however, remain very influential, even if most recent technology acceptance studies have opted for the extended version of the TAM approach represented by UTAUT. Rather than TAM's PU and PEOU, UTAUT is based on four with four core factors: Performance Expectancy (PE), Effort Expectancy (EE), Social Influence and Facilitating Conditions. PE is roughly equivalent to TAM's Perceived Usefulness and EE to Perceived Ease of Use. However, the two extra factors are expected to be significant in a Saudi context, particularly Social Influence, because of the collectivist nature of Saudi society.

However, the UTAUT model still approaches technology acceptance from an organisational point of view, inherited from TAM. When applied to the health field, it has tended to be used to gauge professionals' likely attitudes towards technology, rather than consumers'. As Sun et al (2013) point out, in their discussion of health-related user acceptance studies, "most of these studies focus on investigating the professionals' technology acceptance rather than the patients' technology acceptance. One of the interesting findings of these studies is that perceived ease of use has no significant impact on behavioral intention, because professionals may exhibit considerable competence and adaptability to new technologies…However, when examining the patients' technology acceptance behavior, the conclusion may not hold true, requiring further empirical examination" (p. 187). Venkatesh et al incorporated three constructs into UTAUT, i.e. hedonic motivation, price value, and habit, which link, via individual differences in age, gender and experience, to behavioural intention and technology use. The researchers gathered results from "a two-stage online survey, with technology use data collected four months after the first survey, of 1,512 mobile Internet consumers" which supported their model (Venkatesh et al, 2012). "Compared to UTAUT, the extensions proposed in UTAUT2

produced a substantial improvement in the variance explained in behavioural intention (56% to 74%) and technology use (40% to 52%)" (ibid).

UTAUT2 extends the applicability of UTAUT to consumer technology, where the decision-making does not lie with the professional. As mentioned above, UTAUT2 incorporates three new constructs into UTAUT: a) hedonic motivation, b) price value and c) habit. These would seem highly relevant to our context, where a) fitness apps are considered similarly to entertainment apps or games, where b) they are paid for by the consumer and c) where their place on a user's mobile phone means that there are strong opportunities for usage to be habitual, especially if automated reminders are implemented. For this reason, we have selected UTAUT2, which we described in detail in Chapter Two, as the model for this study.

In addition, drawing on evidence from the literature review (Section 2. 4.3), we introduce three additional factors, namely Trust, Privacy and Valuation of Health, as potential additional factors whose influence we test in the study. This has the drawback of introducing even more complexity into the model. However, we believe that these factors may be significant and therefore need to be tested. Other recent work in this area has highlighted the importance of perceptions of risk and trust. For instance, in a very recent study of m-commerce acceptance in Cameroon, Verkijika found that the "addition of perceived risk and perceived trust were seen to play a vital role in influencing the behavioural intention to adopt m-commerce… Perceived trust was found to have the highest influence on behavioural intention, thus supporting the need for including trust as an added factor in the UTAUT2" (2018).

#### *3.2.7.3 Methods for the Model*

Almost all research projects based on UTAUT employ a large-scale questionnaire as their main data collection tool. The use of a questionnaire to gather a large number of data points can be seen as a way of giving rigour to a study, while still allowing us to collect subjective data on people's feelings and attitudes. In this sense, it brings a positivist approach to qualitative data.

An interesting counter-example is the work of Renaud, K. and Van Biljon (2008), who used a range of methods while working with elderly people to gauge acceptance of mobile phones, including a small-scale (N=34) questionnaire administered one to one in person by a researcher. This was justified by both the exploratory nature of the topic and the nature of the subjects, who responded much more easily to human interaction than to a written questionnaire. This close contact also helped to ensure that the subjects clearly understood the questionnaire topic and questions, which is sometimes an uncertain factor in remotely administered questionnaires. This study illustrates the possible approaches to implementing TAM-like studies. In the case of Renaud, small numbers of subjects were a by-product of a rich interaction with the subjects. In the present study, we chose to target higher numbers, but balanced the impersonality of the remote questionnaire with a focus group and also a pilot study, to minimise the problems inherent in the online survey method. It is worth mentioning here that more sustained use of focus groups would have been very problematic in this study due to the social problems around male-female interaction in Saudi society.

The questionnaire has therefore been our main data collection tool, combined with a focus group to refine the design. The specific decisions on the design of our data collection methods are discussed in the next section.

## 3.3 Data Collection Methods

This section will cover the methods used to collect data for this research, including brief descriptions of alternative approaches and justifications for the choices made. In Chapter Four we will describe how the planned methods were actually implemented.

### 3.3.1 Focus Groups

Like the vast majority of studies that investigate UTAUT and technology acceptance in general, this study used a questionnaire-based survey. One approach would be to simply take the UTAUT constructs and design or re-use questions for each. However, given that this study is in a setting very different from the US context in which UTAUT was developed, and because we are

studying a new phenomenon, i.e. mHealth apps, it is important to take the opportunity to reflect on other factors that might be relevant in these circumstances via some preliminary research.

The introduction has highlighted some issues that might be important, such as social relations in Saudi Arabia, the technology context and local diet and exercise habits. In addition, literature in the area of technology acceptance, mobile health and (in Chapter One) cross cultural difference, was reviewed in order to understand the state of the art and the current "big issues" in consumer mHealth acceptance, to understand current approaches to mHealth in the Saudi context and to develop a good understanding of the research methods and theoretical frameworks that had been brought to bear on the topic.

In particular, the literature review allowed us to explore the factors that form part of the UTAUT2 framework and to propose extra variables that might make the model a better fit for mHealth and for Saudi Arabia.

In order to refine and check the proposed questionnaire items, we then conducted a focus group study of potential app users who were similar to the target study sample. This is in line with the advice of the Pew Research Group: "[s]urveyors may conduct pilot tests or focus groups in the early stages of questionnaire development in order to better understand how people think about an issue or comprehend a question" (Pew Research Center, n.d.).

A focus group was arranged as an initial exploration of the subjective feelings of target consumers of mobile health apps for Saudi Arabia. According to Sim (1998, p.345-352), "the idea behind the focus group method is that group processes can help people to explore and clarify their views in ways that would be less easily accessible in a one to one interview". A focus group is usually conducted in a non-structured and natural manner with small group of participants and a moderator sets the purpose of the interview. A focus group is normally comprised of 6-12 members, as it could not achieve its goals if it is more or less than that number. As for the interview environment, Malhotra and Birks (2003) proposed that a relaxed and casual environment helps members to overlook they are being addressed and watched. The activity should not last

too long: Malhotra and Birks (2003) proposed that from one and half hour to two hours is the suitable length for the focus group interview. Furthermore, the members of the focus group should share some common attributes as far as demographics and financial qualities.

The objective of the focus group with young adult Saudi smartphone users was to explore their attitudes to using some of health-related apps on the market. This would provide a way of checking the relevance of the model variables that we were intending to explore in the questionnaire study, and, perhaps more importantly, to check that there were no major issues for this group that we had missed in the literature review and in the review of Technology Acceptance models. We were exploring:

(1) participants' current experiences of using health-related smartphone apps,
(2) their views on a range of different features, technologies, and capabilities that characterize currently available or future apps.
(3) the kind of health-related apps that they might be likely to use in the Saudi setting

In Chapter Four we report on the focus group and the knowledge it generated.

### 3.3.2. Questionnaire Study

This section describes the main research instrument, the questionnaire, which targeted both users and non-users of mobile health apps in a population of young Saudi Arabians. Here we describe the development of the questionnaire. In Chapter Four we describe its delivery, while results are analysed in Chapter Five.

#### *3.3.2.1 Instrument development*

There are many stages in the development of most questionnaires. According to the Pew Research Center, these can include: identifying topics to cover, identifying change over time and deciding on open vs closed questions. In the present case, some of these decisions were already taken. The main topics, apart from any new constructs that may emerge from literature review of preliminary focus groups, are set, corresponding to the UTAUT constructs.

Most of the items in the survey were taken from previously published studies as shown in the following Table 3.3. Wherever necessary, the items were modified to fit the context of acceptance of mobile health applications and, importantly, to apply to both users and non-users of fitness apps. Suggested measurement items were sourced from a literature search of previous UTAUT and UTAUT2 studies, both in mobile health and in other domains. This section will describe the development of the list of items by constructs.

| Construct | Number of items | Source/Reference |
|---|---|---|
| UTAUT2 Factors | | |
| Performance Expectancy | 4 | Venkatesh, Thong & Xu, 2012 |
| Effort Expectancy | 4 | Venkatesh, et al. 2012 |
| Social Influence | 3 | Venkatesh, et al. 2012 |
| Facilitating Conditions | 4 | Venkatesh, et al. 2012 |
| Hedonic Motivation | 3 | Venkatesh, et al. 2012 |
| Price Value | 3 | Venkatesh et al., 2012; El-Wajee, Galal-Edeen & Mokhtar, 2014 |
| Habit | 4 | Venkatesh, et al. 2012 |
| Initial Usage Intention | 3 | Venkatesh, et al. 2012 |
| Continued Use Intention | 3 | Bhattacherjee, 2001 |
| Additional factors relevant for health app usage | | |
| Trust in the App Developer | 3 | Akter, D'Ambra & Ray, 2011 |
| Perceived Privacy Risks | 5 | Escobar-Rodriguez & Carvajal- |

| | | |
|---|---|---|
| | | Trujillo, 2014 |
| Valuation of Health | 4 | self-developed scale; based on Norman, 1995 |

Table 3.3 Questionnaire items and their sources

The questionnaire is divided into three main parts. The first part is aimed to collect information regarding the participants' demographic status and current state of using smartphones. It requires them to provide information on their gender, educational level and age, and also to provide information about their current use of smartphones. It may be that asking users about the area of the country in which they lived might have provided interesting results, as some areas, e.g. the East of the country, are generally regarded more liberal and open to new ideas than others, which may impact on the acceptance of innovations like fitness apps. Similarly, it would have been useful to have had access to a questionnaire population from the non-urban areas: access precluded this, but again it is a limitation of the study. A more geographically nuanced questionnaire might be an interesting extension of the current project.

The second part explores attitudes to innovation and technology acceptance, including fitness app use. We based this section on Rogers' classification of individuals and their attitudes to new technology, with the assumption that keen and reluctant users might also show differences in UTAUT-related attitudes and behaviours. This section asked respondents to identify with one of five types of technology adopter, as follows:

| |
|---|
| I tend to be a risk-taker and active-information seeker. I am willing to invest time and energy to learn and adapt quickly to new technologies. I tried using fitness apps as soon as they were available, and shared my experience with others. |
| I would explore the fitness app for its potential to bring about improvements in my weight management. I am willing to try new things, and am not averse to occasional failure. However I want to see someone else using the fitness app successfully before I adopt it. |
| I would adopt a "wait and see" attitude toward the fitness app, and wanted examples of close-to- home successes before adopting. I wanted to see the value of the fitness before adopting it. I wanted to make sure that adoption would be easy and hassle- free and that I would have |

| |
|---|
| the necessary technical support and advice to learn/use the fitness app. |
| I would be sceptical about using the fitness app and accept it later in the game once it had become established among the majority of people around me and the institutional norms favoured adoption. |
| I am usually not interested in adopting new technology and see no use for adopting the fitness app in my weight management, which has worked well so far. |

The third part represents the conceptual framework factors. These factors are as follows:

1. Performance Expectancy (PE) (Venkatesh, Thong & Xu, 2012),
2. Effort Expectancy (EE) (Venkatesh et al. 2012),
3. Social Influence (Venkatesh et al. 2012),
4. Facilitating Conditions (FC) (Venkatesh et al. 2012),
5. Hedonic Motivation (HM) (Venkatesh et al. 2012),
6. Price Value (PV) (Venkatesh et al., 2012; El-Wajee, Galal-Edeen & Mokhtar, 2014),
7. Habit (HAB) (Venkatesh et al. 2012),
8. Initial Usage Intention (IUI) (Venkatesh et al. 2012),
9. Continued Usage Intention (CUI) (Bhattacherjee, 2001),
10. Trust (TRU) (Akter, D'Ambra & Ray, 2011),
11. Perceived Privacy Risks (PR) (Escobar-Rodriguez & Carvajal-Trujillo, 2014)
12. Valuation of Health (VH) (self-developed scale; based on Norman, 1995).

Each item was modified to be suitable for both current users and non-users of mobile fitness apps. Statements were modified for each item, and the participants were asked to indicate whether they agree or disagree with the statement on 5-point Likert scale. However Item 3, Social Influence, was divided into items referring to healthcare professionals on the one hand and to friends and family on the other. This was because it had become clear in the focus group that friends and family and health professionals represented two separate types of influential factor, sometimes in tension. For example, a particular type

of food might be deprecated by health professionals but prized by family. Similarly, while a health professional might recommend exercise, family influence, especially for women, might overrule this.

Wherever possible, questions were sourced from existing studies, to help to ensure face and construct validity (see below, 3.3.4). The first four questions in this section (9-12) were adopted and modified from (Venkatesh, Thong & Xu, 2012). They were designed to determine users' views of the benefits that a consumer obtains from fitness app. They were designed to measure the variable *Performance Expectancy* and to address Hypothesis H1. The questions developed for a fitness app situation are as follows:

> PE1.Original: I find the mobile Internet useful in my daily life.
>
> Modified version: [A/This] Fitness app [would be/is] useful in my daily life.
>
> PE2. Original: using mobile Internet increases my chances of achieving things that are important to me.
>
> Modified: Using [a/this] Fitness app [would] increase[s] my chances of becoming fitter.
>
> PE3. Original: Using mobile Internet helps me accomplish things more quickly. Modified: Using [a/this] Fitness app [would] help[s] me to prevent being over-weight.
>
> PE4. Original: Using mobile Internet increases my productivity.
>
> Modified: Using [a/this] Fitness app [would] help[s] me to manage my weight.

Questions (13-16) were designed to measure the variable *Effort Expectancy* and to address Hypothesis H2.

> EE1. Original: Learning how to use mobile Internet is easy for me.
>
> Modified: Learning how to use [a/this] fitness app [would be/is] easy for me.
>
> EE2. My interaction with mobile Internet is clear and understandable. Modified: My interaction with [a/this] fitness app [would be/is] clear and understandable
>
> EE3. I find mobile Internet easy to use.

Modified: I [would] find [a/this] Fitness app easy to use.

EE4. It is easy for me to become skilful at using mobile Internet.

Modified: It [would be/is] easy for me to become skilful at using [a/this] fitness app.

Questions (17-22) were designed to measure the variable “Social Influence” from two points of view: consumer with relatives (17-19) and consumer with healthcare specialists (20-22), and to address Hypotheses H3a and H3b. The original questions derived from (Venkatesh, et al. 2012):

SI1. People who are important to me think that I should use mobile Internet

SI2. People who influence my behaviour think that I should use mobile Internet.

SI3. People whose opinions I value prefer that I use mobile Internet.

In our version for H3a, family and friends, these become:

SI1: Friends and relatives who are important to me think I should use [a/this] fitness app.

SI2: I [would] use [a/this] fitness app because of the proportion of friends and relatives who use such an app.

SI3: friends’ and relatives’ suggestions [will] affect my decision to use [a/this] Fitness app.

In our version for H3b, healthcare specialists, these become:

SI1: Specialists (i.e. physicians, pharmacists, health insurance) think I should use [a/this] fitness app.

SI2: I [would] use [a/this] fitness app because a specialist recommended it to me.

SI3: Specialists’ support and expertise [will] affect my decision to use [a/this] fitness app.

Questions (23-26) were designed to measure the variable “Facilitating Conditions,” in other words the consumer’s perceptions of the resources and support available in using the technology, addressing Hypothesis H4.

FC1. I have the resources necessary to use mobile Internet.

Modified: I [would] have the resources necessary to use [a/this] fitness app.

FC2. I have the knowledge necessary to use mobile Internet.

Modified: I [would] have the knowledge necessary to use [a/this] fitness app.

FC3. Mobile Internet is compatible with other technologies I use.

Modified: [A/This] fitness app is compatible with other technologies I use.

FC4. I can get help from others when I have difficulties using mobile Internet.

Modified: I can get help from others when I have difficulties using [a/this] fitness app.

Questions (27-29) were designed to measure the variable “Hedonic Motivation” or the fun or pleasure derived from using such a technology, addressing Hypothesis H5.

HM1. Using mobile Internet is fun.

Modified: Using [a/this] fitness app [would be/is] fun.

HM2. Using mobile Internet is enjoyable.

Modified: Using [a/this] fitness app [would be/is] enjoyable.

HM3. Using mobile Internet is very entertaining.

Modified: Using [a/this] [would be/is] very entertaining.

Questions (30-32) were designed to measure the variable “*Price Value”*, the value the consumer obtains from fitness app for its price, and to address Hypothesis H6.

PV1. Mobile Internet is reasonably priced.

Modified: (non-user) I would use a fitness app if it were reasonably

(user) fitness apps are reasonably priced.

PV2. Mobile Internet is a good value for the money.

Modified: (non-user) fitness apps would be more likely to provide a good value of weight management for money.

(user) fitness apps are a good value for money.

PV3. At the current price, mobile Internet provides good value.

Modified: (non-user) Fitness apps would be more likely to provide good value for money.

(user) At the current price, fitness app provides good value for money

Questions (33-36) were designed to measure the variable “Habit,” the need to regularly use a fitness app, and to address Hypothesis H7.

HT1. The use of mobile Internet has become a habit for me.

Modified: the use of a fitness app [has/would] become a habit for me

HT2. I am addicted to using mobile Internet.

Modified: I [am/would be] addicted to using a fitness app

HT3. I must use mobile Internet.

Modified: I [have to/would] use [this/a] fitness app.

HT4. Using mobile Internet has become natural to me.

Modified: Using a fitness app [has/would] become natural to me

Questions (37-39) were designed to measure the dependant variable “*Initial Usage Intention”*, in other words the intention to use fitness app.

BI1. I intend to continue using mobile Internet in the future.

Modified: I intend to use a fitness app in the next 30 days.

BI2. I will always try to use mobile Internet in my daily life.

Modified: I predict I would use a fitness app in the next 30 days.

BI3. I plan to use mobile Internet frequently.

Modified: I plan to use a fitness app in the next 30 days.

Questions (40-42) were designed to measure the dependent variable “*continued usage Intention*”, in other words the continuation to use the fitness app.

CI1 I intend to continue using OBD (online banking) rather than discontinue its use.

Modified: I intend to continue using this fitness app rather than to discontinue its use.

CI2 My intentions are to continue using OBD than use any alternative means (traditional banking).

Modified: I intend to continue using this fitness app rather than using any alternative.

CI3 If I could, I would like to discontinue my use of OBD (reverse coded).

Modified: I will not discontinue my use of this fitness (positively coded).

Questions (43-45) were designed to measure the variable "*Trust"* or the confidence in the fitness app provider, and to address Hypothesis 8. The instruments were based on those from another mHealth program, Grameen mHealth.

TR1 I feel that I would trust Grameen mHealth for reliable medical information services.

Modified I [would] trust [a/this] app to provide reliable information and functions.

TR2 I feel that I would trust Grameen mHealth's promises and commitment to satisfy my medical information needs.

Modified: I [would] trust [a/this] fitness app promises and commitment to satisfy my health needs to manage my weight.

TR3 I feel that I would trust Grameen mHealth's behaviour to meet my expectations.

Modified: I [would] trust [a/this] fitness app to meet my expectations.

Questions (46-50) were designed to measure the variable "*Anticipated Privacy Risks"* and to address Hypothesis 9. Again, the original question mentions a different context.

PP1. I am concerned that LCC e-commerce websites collect too much personal information from me.

Modified: I am concerned that [a/this] fitness app [would] collect[s] too much personal information from me.

PP2. I am concerned that the LCC e-commerce websites will use my personal information for other purposes without my authorization.

Modified: I am concerned that [a/this] fitness app [would] use[s] my personal information for other purposes without my authorization.

PP3. I am concerned the LCC e-commerce websites will share my personal information with other entities without my authorization. Modified: I am concerned that [a/this] fitness app [would] share[s] my personal information with other entities without my authorization.

PP4. I am concerned that unauthorized persons (i.e. hackers) have access to my personal information. Modified: I am concerned that unauthorized persons (i.e. hackers) [would] have access to my personal information.

PP5. I am concerned about the privacy of my personal information during a transaction. Modified: I am concerned that using [a/this] fitness app [would] cause[s] me to lose control over my information.

Questions (51-54) were designed to measure the variable "*Valuation of Health,"* in other words the degree to which consumers believe it is Important and worthwhile to follow a healthy-lifestyle. This addresses Hypothesis H10. This factor is a self-developed scale. This study argues that the more users believe in the importance of health and the effectiveness of leading a healthy lifestyle, the more he/she will intend to use the technology (see Section 2.4.3 above). The questions are:

VH1: The condition of my health would be better if I followed a healthy lifestyle.

VH2: The condition of my health is important to me.

VH3: Following a healthy lifestyle would have a positive impact on my future health.

The questionnaire is presented in Appendix 2.

#### *3.3.2.2 Testing and validation*

Chilisa & Kawulich, 2012, provide an interesting description of attitudes to validity in interpretivist and positivist traditions:

> II]n a qualitative study, whether within the constructivist or interpretivist, transformative, or post-colonial indigenous framework, the emphasis is on persuading the reader that the findings resulted from the data and were not simply made up by the researcher. You will need to provide rich

> description of your procedures and resulting findings, typically including quotes or other data to substantiate the veracity of your findings.

This relates in particular to the focus group results.

> In a quantitative/positivist study, you stress those things that you did to convince the reader that you used established procedures and did not simply rely on your own judgement (Firestone, 1987). This means including a full description of the sample, the methods used to collect data, the statistical procedures used to analyse them and the results of the study" (Chilisa & Kawulich, 2012)

This is what we have attempted do in preliminary form in this chapter, with Chapters Four and Five adding detail on practical implementation and statistical analysis.

A number of steps were used to validate the questions used in the questionnaire and the questionnaire itself. These were aimed at addressing as many aspects as possible of validation, as identified by Tsang et al (2017). The model of Tsang et al is an ideal system, designed for large research projects. In particular, as this is a one-person project, some aspects involving multiple designers have not been implemented. However, in the following sections, we discuss the various steps taken to ensure the relevance and reliability of the questionnaire. The first of Tsang's steps is to establish, via literature review, that no appropriate questionnaire already exists that addresses the same population. As we have seen, similar questionnaires do exist, though not in Arabic. This has made it possible to re-use a large number of questions, in translated form. Once this was established, a small number of extra questions were added to reflect the Saudi population and the specific topic of mobile health, as detailed above. The first stage of validating these questions was a pilot study.

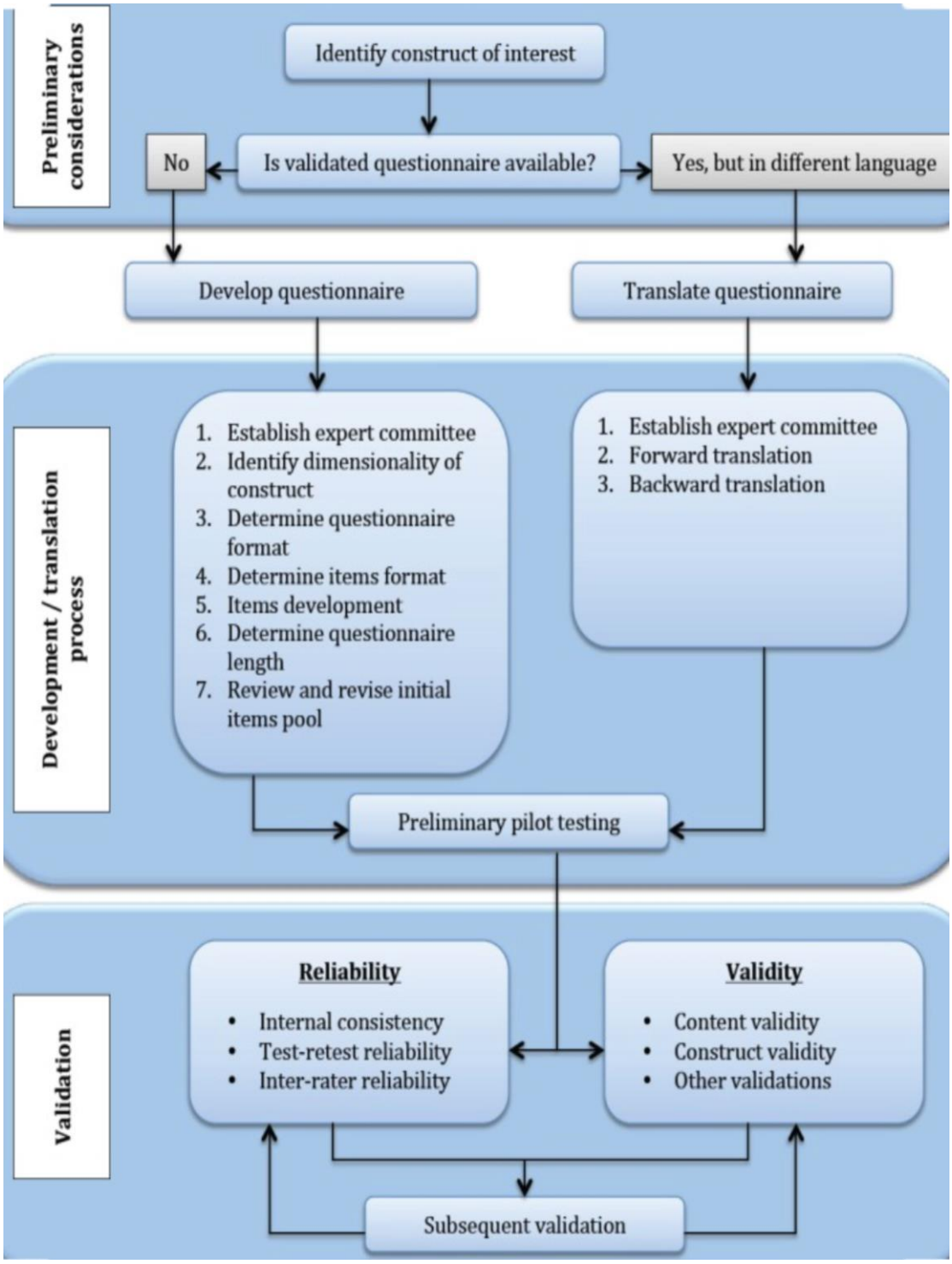



Figure 3.1 Validation Stages (Tsang et al, 2017)

.

### *3.3.2.2.1 Pilot Study*

A pilot study was carried out to assess the questions' face validity and assess the reliability of data collected: ensuring that the questionnaire was worded

correctly in a way that respondents can understand unambiguously can reduce the possibility of getting misleading results (Saunders et al., 2003). Saunders et al (2003) recommended that the minimum number of a pilot study is ten: in this study twenty Saudi students aged 18-35 took part, in face to face sessions with the researcher. We used the cognitive interviewing method proposed by Drenna- (2003) in asking respondents to think aloud as they carried out the questionnaire, allowing us to assess how they understood the questions, as well as practical issues of length and timing.

It was found that the minimum time that participant take to finish the questionnaire was about 25 minutes, and the maximum time was 45 minutes, which is useful information for participants.

Contrary to expectations, we found that some respondents already had experience of mobile fitness apps. This presented the opportunity to compare users and non-users, and the questions were modified accordingly so that they were appropriate for both.

In terms of content, it was found that the participants (who were not those who had attended the focus group session) did not understand the idea behind the chatbot-based application that was referred to tin the first version of the questionnaire (Note: this was the original focus of the PhD project, subsequently modified). At this point, it was realised that a different approach was needed. A range of more conventional fitness apps were identified and illustrated in the questionnaire (see Appendix 2) so that respondents would be more confident about the subject of the research: this was confirmed in a further small pilot study.

Thus the pilot study had a very important impact on the design of the questionnaire, involving the design of new questions but also establishing the face validity of the instrument as a whole.

#### *3.3.2.2.2 Reliability*

We used the questionnaire results to check the reliability or construct validity of the questionnaire, using the Cronbach's alpha test. Cronbach's alpha gives us a simple way to measure whether or not a score is reliable. It is used under the

assumption that a questionnaire often contains multiple items measuring the same underlying construct: a survey might have a number of questions all asking different things, but when combined, could be said to measure the same overall construct.

The study explores the factors that affect the acceptance of fitness apps within the context of mHealth in Saudi Arabia by testing the applicability of Extended unified theory of acceptance and use of technology (UTAUT2) model within mHealth context. Seven items or constructs explored were as suggested by Venkatesh et al. (2012), i.e. performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivation, price value, and habit. However, some items have been modified and words changed for the purpose of this study. Firstly, social influence was split into two separate items, on the one hand, friends and family and on the other hand, healthcare professionals. It was felt likely, based on the cultural dimensions of Saudi society, that these groups would exert different influences. Moreover, three extra items, relating to trust, privacy and health-related attitudes, were added to the framework to be operationalized based on related studies explored in Chapter Two.

To test whether the questions used are reliable, Cronbach's alpha was computed by means of the statistical software SPSS. An overview of the scores can be seen in Table 3.2:

| Measurement Scales | Items (UserAnd NonUser) | α (User) | M (User) | SD (User) | α (NonUser) | M (NonUser) | SD (NonUser) | Skewness User | Kurtosis User | Skewness NonUser | Kurtosis NonUser |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PE | 4 | 0.942 | 3.905 | 3.706 | 0.928 | 3.795 | 3.532 | -1.212 | 2.153 | -0.729 | 0.807 |
| EE | 4 | 0.942 | 3.949 | 3.421 | 0.927 | 3.873 | 3.23 | -1.126 | 1.852 | -1.088 | 2.098 |
| SIF | 3 | 0.87 | 2.845 | 3.289 | 0.85 | 3.258 | 3.022 | 0.062 | -0.748 | 0.013 | -0.549 |
| SIS | 3 | 0.837 | 2.855 | 3.007 | 0.777 | 3.748 | 2.374 | -0.008 | -0.531 | -0.512 | 0.732 |
| FC | 4 | 0.821 | 3.649 | 3.086 | 0.819 | 3.725 | 2.972 | -£0.853 | 1.728 | -£0.602 | 1.280 |
| HM | 3 | 0.937 | 3.619 | 2.78 | 0.912 | 3.633 | 2.725 | -0.620 | 0.236 | -0.496 | 0.266 |
| PV | 3 | 0.853 | 3.673 | 2.532 | 0.892 | 3.573 | 3.215 | -0.366 | 0.155 | -0.693 | -0.165 |
| H | 4 | 0.908 | 3.188 | 3.943 | 0.928 | 3.348 | 3.652 | -0.180 | -0.325 | -0.287 | 0.315 |
| Trust | 3 | 0.905 | 3.663 | 2.456 | 0.931 | 3.567 | 2.706 | -0.836 | 1.358 | -0.674 | 0.653 |
| Privacy | 5 | 0.954 | 3.077 | 5.428 | 0.958 | 3.087 | 5.851 | -0.121 | -0.628 | -0.146 | -0.817 |
| VH | 4 | 0.968 | 4.462 | 2.972 | 0.871 | 4.277 | 3.03 | -1.850 | 4.255 | -1.596 | 3.579 |
| CU | 3 | 0.895 | 3.542 | 2.746 | | | | -0.715 | 0.894 | | |
| ITU | 3 | | | | 0.954 | 3.495 | 2.779 | | | -0.436 | 0.192 |

Table 3.2 Cronbach's Alpha for questionnaire items

KEY:

PE: Performance Expectancy,

EE: Effort Expectancy,

SIF: Social Influence: Friends and relatives,

SIS: Social Influence: Healthcare specialists,

FC: Facilitating Conditions,

H: Hedonic Motivation,

PV: Price Value,

H: Habit,

Trust: Trust,

Privacy: Perceived Privacy Risk,

VH: Valuation of Health,

CU: Continuing Usage Intention and

ITU: Initial Usage Intention.

The items were measured on a 5-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree).

A measurement with Cronbach's alpha value of more than 0.7, are considered a more reliable. From Table 5.5 it can be seen that all factors having a Cronbach's Alpha coefficient are higher than 0.7 for all the scales of measurement. The Valuation of Health items, which were self-generated, score relatively highly. The lowest scoring items are all in the areas of Facilitating Conditions and Social Influence, which should be kept in mind when those results are discussed. However even those items achieve acceptable scores.

#### *3.3.2.3 Questionnaire Translation*

Banville, Desrosiers and Genet-Volet (2000) argue that when a research instrument is developed for a different culture, it is important to translate the instrument and validate it in the target culture to verify its meaning. In this study, the questionnaire was written in English, from English language sources. Since the participants are located in Saudi Arabia and would have Arabic as their first

language, the questionnaire was translated into Arabic. The overall approach was taken from Tsang et al, 2017. This translation was carried out by two bilingual individuals, who speak both English and Arabic, who were asked to perform “forward translations” and “back translation”. One translator (the researcher) translated the English into Arabic, and another translator subsequently converted the Arabic translation back into English. After that, both of the translators reviewed the forward and backward versions in order to iron out any linguistic differences and agree on the final version in the Arabic language, since using direct translation can lead to discrepancies relating to meaning. Supervisors acted as an expert review team to monitor the quality of the final English version, while the pilot test also tested the comprehensibility of items. The English version of the questionnaire is presented in Appendix 2: the Arabic version is available on request.

### 3.3.3. Sample Design

The sampling frame for this study was young Saudis living across the country. If “young” is under 35, this would give a total target population of approximately 20,000,000 (of a population of approximately 38 million), clearly too large a population to work with directly. The aim was to reach young people from different parts of the country, of different educational backgrounds and both genders. The potential target participants for this study were very difficult to reach directly for a number of reasons. Firstly, they were in different geographic locations in Saudi and travel expenses were prohibitive. Secondly, it was difficult to approach directly half the sample, i.e. female respondents, to complete the questionnaire face to face. In this research, the researcher attempted at several points to obtain access to the female participants, but it was unsuccessful: the female participants refused to be interviewed by a male researcher. The researcher tried to use an alternative approach by hiring a female interviewer to get access to the female participants, but this was also unsuccessful as the female participants refused to be recorded or filmed. It was difficult to obtain permission from their male guardians, in such a conservative context.

Limited access to the participants and limited sources may also result in the decision to use one or more of non-probability sampling techniques (Saunders

et al., 2003) and in this case, we sent out a general invitation to students in five universities in Saudi Arabia to complete the questionnaire, using self-selection. Therefore, due to gender differences, financial, time and resource constraints, the survey studies could not be conducted through personal interviews. Of the various techniques of statistical sampling devised to obtain samples taken from larger populations, we used a volunteer-based self-selection method, sending out questionnaires to the student body of five Saudi universities. These were:

King Saud University in Riyadh (the Middle region)

King Abdulaziz University in Jeddah (the West region)

King Faisal University in Hofuf (the East region)

Northern Borders University in Arar (the North region)

Jazan University in Jazan (the South region)

The universities were selected to represent the whole country, as can be seen in the map in Figure 3.2. The population of the Saudi universities according to the Saudi Ministry of High Education is as follows:

King Saud University in Riyadh 66,020 students

King AbdulAzizUniversity in Jeddah 132,094 students

King Faisal University in Hofuf 60,228 students

Northern Borders University in Arar 8,386 students

Jazan University in Jazan 33,862 students


Figure 3.2 Map of cities of Saudi Arabia (Google maps 2017)

The place of the self-selection sampling technique in the wider range of possible sampling techniques is shown in Figure 3.3. Self-selection is a limitation of this study: however, this limitation can be addressed by matching the demographics of the sample with the demographics derived from known population data.

When it comes to an acceptable size for the sample, there are two main aspects to account for. The first is confidence level. For a 90% confidence level (which means that there is only a 10% chance of your sample results differing from the true population average), a good estimate of the margin of error (or confidence interval) is given by $1/\sqrt{N}$, where $N$ is the number of participants or sample size (Niles, 2006).

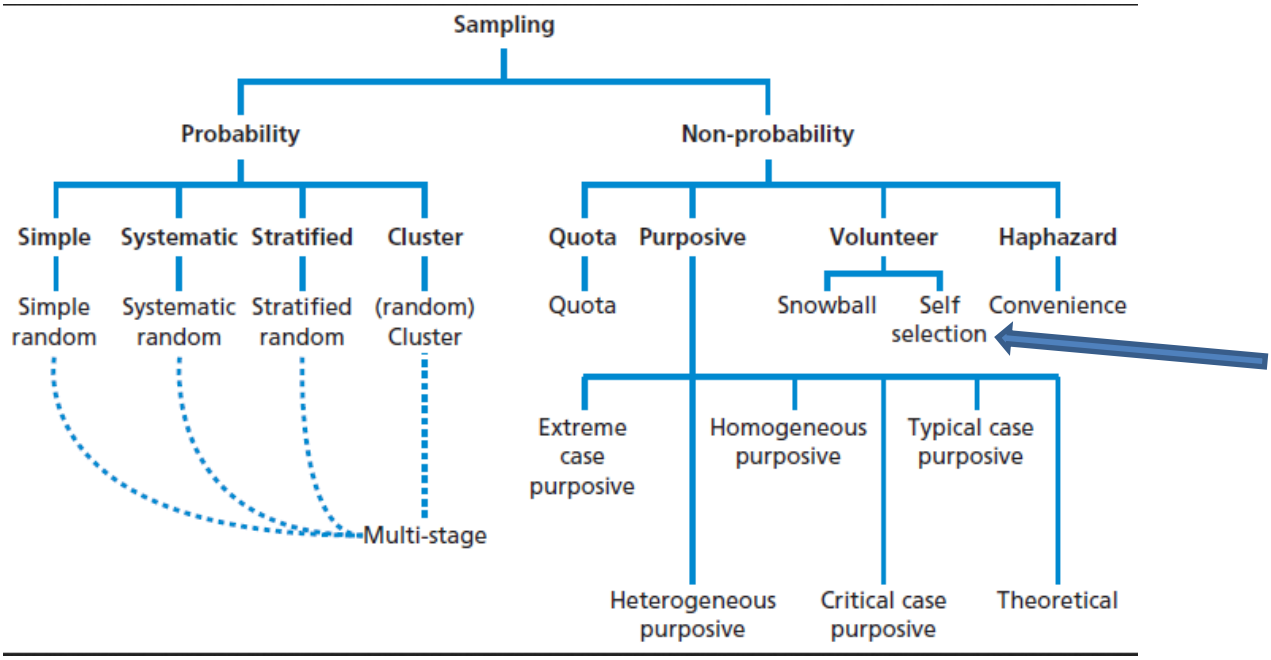



Figure 3.3 Categorisation of sampling techniques (https://research-methodology.net/)

The following table, from Nile 2006, shows this estimate of the margin of error for sample sizes ranging from 10 to 10,000.

| Sample Size (N) | Margin of Error (fraction) | Margin of Error (percentage) |
|---|---|---|
| 10 | 0.316 | 31.6 |
| 20 | 0.224 | 22.4 |
| 50 | 0.141 | 14.1 |
| 100 | 0.100 | 10.0 |
| 200 | 0.071 | 7.1 |
| 500 | 0.045 | 4.5 |
| 1000 | 0.032 | 3.2 |
| 2000 | 0.022 | 2.2 |
| 5000 | 0.014 | 1.4 |
| 10000 | 0.010 | 1.0 |

With a sample size to 100 people, the margin of error is 10%. In this case, if 60% of the participants reported a certain attitude, there would be a 95% probability (the standard level of confidence in quantitative research) that

between 50% and 70% of the total population have the same attitude. This is often seen as the highest acceptable margin of error. Ding, Velicer and Harlow (1995) argue that minimum sample size when running a questionnaire in this way is 100 to 150. In this study, the minimum sample size was set at 150 for each set of data, i.e. users and non-users of mobile health apps. This gives a total of 300 for all questions but 150 when users and non-users are compared. It might have been possible to build up to 250 respondents for each data set, giving a total of 500, and hence a 5% margin of error. However, after a range of approaches over three months (see Chapter Four for details) 300 was the highest number we were able to recruit.

The sample size in this research has an impact on the reliability of the research outcomes (Saunders et al., 2003). Generally, the interviewer-administered questionnaires have a higher response comparing with self- administered questionnaires (Saunders et al., 2003). However, as mentioned before, it was difficult to obtain the target responds from the target sample, so, the online questionnaire was the appropriate way that would obtain the substantial number of responses. This provides good access to respondents of both genders and, because University mailing lists were able to be used, from a good range of sites across the country, in comparable settings. In addition, this is the approach regularly used in UTAUT-based studies.

## 3.4 Conclusion

In this chapter we have explained our overall research approach, describing the data that we aimed to capture, the methods of data collection we selected and designed, the choice of model used for designing our instruments and for data analysis and the targeted sample.

In the next chapter, we describe how we implemented these methods and how they turned out in practice.

# Chapter Four: Research Methods in Practice

## 4.1. Introduction

This chapter presents the practical execution and progress of the research methods used in the study. We have attempted to distinguish between the planning and design activities covered in Chapter Three and the more practical and pragmatic aspects dealt with here: however, there are inevitably some area where points previously covered are repeated.

## 4.2. Summary of Research Design

This research explores the factors that influence users' acceptance of mobile health applications for a healthy lifestyle, approaching the study using the UTAUT2 theoretical framework. The research explores subjective human attitudes: therefore, the data needed to answer the research questions will be qualitative in nature. The project seeks to test a set of factors and relationships, as set out in the UTAUT2 model, discussed above, as well as the three extra factors identified as important via the literature review. These were Trust, Privacy concerns and Valuation of health.

Like the vast majority of studies that investigate UTAUT and technology acceptance in general, this study used a questionnaire-based survey. However, in order to refine and check the proposed questionnaire items, we first conducted a focus group study of potential app users who were similar to the target study sample.

## 4.3. Methods

This section will cover the implementation of the methods used a) to prepare the ground for the study and b) to collect data for this research.

### 4.3.1. Literature Review

Literature in the area of technology acceptance, mobile health and (in Chapter One) cross cultural difference, was reviewed in order to understand the state of the art and the current "big issues" in consumer mHealth acceptance, to

understand current approaches to mHealth in the Saudi context and to develop a good understanding of the research methods and theoretical frameworks that had been brought to bear on the topic. In particular, the literature review allowed us to explore the factors that form part of the UTAUT2 framework and to propose extra variables that might make the model a better fit for mHealth and for Saudi Arabia.

#### *4.3.1.1 Research Hypotheses*

In Section 2.4.2.3 and 2.4.2.4 of the literature review, we discussed the factors making up UTAUT2 and the three extra factors of Trust, Privacy concerns and Health valuation, setting out the expected relationships and effects of each. Expressed more formally, the hypotheses that emerged from the literature review were as follows:

H1: performance expectancy positively affects intention to use and continuation to use fitness apps.

H2: effort expectancy positively affects intention to use and continuation to use fitness apps.

H3a: social influence created by friends and relatives positively affects intention to use and continuation to use fitness apps.

H3b: social influence created by health specialists positively affects intention to use and continuation to use fitness apps.

H4: facilitating conditions positively affect intention to use and continuation to use fitness app.

H5: hedonic motivation positively affects intention to use and continuation to use fitness app.

H6: price value positively affects intention to use and continuation to use fitness app.

H7: habit positively affects intention to use and continuation to use fitness app.

H8: trust positively affects intention to use and continuation to use fitness app.

H9: perceived privacy risks negatively affect intention to use and continuation to use fitness app.

H10: valuation of health positively affects intention to use and continuation to use fitness app.

H11: trust moderates perceived privacy risks.

### 4.3.2. Focus Group

A focus group was arranged as an initial exploration of the subjective feelings of target consumers of mobile health apps for Saudi Arabia. According to Sim (1998, p.345-352), “the idea behind the focus group method is that group processes can help people to explore and clarify their views in ways that would be less easily accessible in a one to one interview”. A focus group is usually conducted in a non-structured and natural manner with small group of participants and a moderator sets the purpose of the interview. A focus group is normally comprised of 6-12 members, as it could not achieve its goals if it is more or less than that number. As for the interview environment, Malhotra and Birks (2003) proposed that a relaxed and casual environment helps members to overlook they are being addressed and watched The activity should not last too long: Malhotra and Birks (2003) proposed that from one and half hour to two hours is the suitable length for the focus group interview Furthermore, the members of the focus group should share some common attributes as far as demographics and financial qualities.

#### *4.3.2.1 Objectives*

The objective of the focus group with young adult Saudi smartphone users was to explore their attitudes to using some of health-related apps on the market. This would provide a way of checking the relevance of the model variables that we were intending to explore in the questionnaire study, and, perhaps more importantly, to check that there were no major issues for this group that we had missed in the literature review and in the review of Technology Acceptance models. We were exploring:

(4) participants' current experiences of using health-related smartphone apps,
(5) their views on a range of different features, technologies, and capabilities that characterize currently available or future apps.
(6) the kind of health-related apps that they might be likely to use in the Saudi setting

#### *4.3.2.2 Method*

For this study, a focus group was set up with UK university students from Saudi Arabia. The aim of this focus group was to identify why consumers in a Saudi context would intend to use mobile health applications. It would be natural to have run this session in Saudi Arabia. However as it is very difficult to run mixed gender groups in Saudi Arabia, and the researcher wanted to encourage synergy, it was decided to run the group in the UK.

This group of people represent users of smartphones, so it was easy for the group members to discuss their attitudes toward mobile health applications. We recruited eight participants, of whom four females and four males, with range of age between 19 and 31. All were Saudis. The process of recruiting the participants was snowball sampling, via friends' invitations. The researcher is a Saudi national so the friendship helps him in getting the participants to take part in the study.

It should be said that there were problems in having the participants to participate in the research: it was difficult to persuade female participants to take part in the study alongside men, even though they finally agreed to participate: it was also difficult to gather all the group members in the same time. In retrospect, the aspiration to mix male and female participants may have been a misjudgment: a better solution might have been for the researcher to conduct a male only session and for a female colleague to have worked with an all-female focus group. Although most participants in this study were Saudi students, this was not an issue for this study. In the current context, they are suitable, being experienced users of mobile phones, and a potential target group for mobile health applications.

At the time of the study, four of the participants owned iPhones, three owned a Sony android and one Nokia with Windows 7. The participants were relatively frequent users of their phones, with all but one user reporting at least one hour of use per day. All of them reported using non-call features (e.g. apps, camera, Internet, multimedia) “often” or “very often” and only one used these “rarely”. Five participants indicated that they had previously sought health-related advice or information from the Internet or other forms of technology. The study was led through open questions, prepared in advance.

For this research, the focus group interview was held in quiet room, which has offered a friendly and informal atmosphere. The focus group interview lasted just under an hour. A brief introduction and description of the mobile applications for health were given to the members. Since participants might not be familiar with mHealth apps, the facilitator introduced them using different sorts of documentation, such as power-point slides presentation, video clips and mobile applications running in smartphones. After that, participants had a chance to view and try an app themselves. The main app selected was MyFitnessPal, which offers both exercise and diet support. Participants were also encouraged to download six apps providing as wide as possible a range of functionality and styles of interaction. having different types of methods to deal with weight-loss (scanning BMI, Tracking ,social and interaction agent), giving advice, tips, and information on health (Health Tips 1000 application), tools to monitor behaviour, mood and well-being (MonitorYourHealth application), issuing reminders and prompts for healthy behaviours (Exercise Reminder application), allowing the sharing of progress through online social media (iRunner application) and providing a virtual agent that can provide friendly chat with the user (Alice application). As a backup, to avoid any technical problems during the focus group session, a PowerPoint presentation was prepared with pictures showing the applications and their features.

The discussion began with questions around participants’ personal experiences of smartphone apps for health. The following basic questions were asked:

A. How do you use your mobile phones?

B. What do you expect from mobile health applications (fitness app)?

C. Why do you want to use mobile health applications (fitness app)?

D. What are your concerns about mobile health applications (fitness app)?

Participants were then asked to describe their thoughts and feelings about the features of these types of apps, including their perceived usefulness, relevance, and concerns. Difficulties may happen during the focus group process (Malhotra and Birks, 2003). For instant, when group dynamics work well the participants work alongside the researcher, but the unstructured nature of the responses may take the research in new and often unexpected directions. Thus, for this study, it was decided to use some key questions that help to lead the session. This worked well, and the conversation started to be guided by participants themselves with the researcher providing some hints to keep the conversation in the same track.

Nevertheless, it is accepted that focus group members might not be willing to discuss sensitive or personal information with other people (Morgan, 1998). Thus, in this study, it was difficult for the researcher to create an atmosphere where female participants felt comfortable discussing health and fitness health information. For example, a video or even audio recording would have facilitated recording the discussion, but female participants refused to be recorded in any way, making written notes the only option.

#### *4.3.2.3 Results*

The transcripts were analysed using inductive thematic analysis. The key themes discussed were smartphone using to provide information, desire to use such an app for weight loss, Saudi infrastructure, social network and sharing data.

*Current Smartphone Use*

All participants have agreed on the importance of using smartphones and the information that is accessible by smartphones. Participants access the internet frequently using their smartphones: health information is a kind of information that they often obtain. Participants describe the different causes of using smartphones, from maps to specialists using the phone for their special needs and also for entertainment during their private time. Using smartphones for

religious aspects is very common with all participants such as a Qur'an app, Azan (call to prayer notification) and Mecca finder (for orientation during prayer).

*Desire to use mobile app for health*

Participants liked apps that provided convenient tools to help them to monitor, track, and review attempts to change or improve health behaviour. Three of participants lived outside the major cities, so they saw the potential benefits of using mobile app for health care.

Two participants cited financial obstacles to accessing healthcare in distant cities: "Spending money to travel is the major problem" (F2, M4), while another valued communication with her father's medical career: "I really need an app to connect me with my dad's doctor" (F3).

*Using social networks*

Participants are not sure about sharing knowledge about their health status. The four female participants said they would refuse to share health and exercise details, particularly about obesity. This might change if they were assured of anonymity. Two participants had no problem with sharing and two were not sure.

The female participants commented as follows:

"I can't say to people I was fat, but now I am losing some weight." (F1)

"If I share my knowledge with my friends they will make fun of me." (F2)

"My dad wouldn't let me use social networks." (F3)

"There is no reason to share." (F4)

This is interesting because it contradicts findings from other research. For instance, Alnasser et al (2015), in their focus group study of what overweight Saudi women want from a weight loss app, report that he most common theme from their discussions seemed to be "the emphasis on motivational support and social networking. The majority of all groups stated that "there has to be

communication" [Participant 7; FG 2]. Numerous women indicated that having a social support network would be motivating. For example, one participant said, "The app itself should be like Instagram," in which women checked up on each other as a group motivator [Participant 1; FG 2]."

*Reactions to an intelligent app*

Participants were curious about the ability of smart phones to provide smart agents dealing with them like a friend (as demonstrated to the group in the Alice chatbot). Several participants talked about needing or wanting to be reminded of certain things, or prompted to take certain action and felt their phone could do this successfully.

> "I think I need pushing into doing anything." (F1, F2, M4)
>
> "I think I'm a person that responds well to little prompts." (F4)
>
> "I don't really get up and do things myself." (M2, M1)

All participants agreed how attractive the chatbot was and said they would love to have it: "If I got a message saying "you've done really well", from a character, that would be amazing (F2). Cultural congruence was important to some: "If it has a Saudi avatar with Saudi style and way of language I would use it" (F2, F3) and "I will feel relax with an application looking like me" (F1, M2, M3). The chatbot is seen as an alternative to social networking: "I would prefer to talk with some virtual agent rather than share my data with strangers" (F2)

Overall, the chatbot concept was seen as attractive: "It's so much fun I am gonna use it (M2)" and "Wow, if it has the avatar of Johnny Depp" (F4).

#### *4.3.2.4 Conclusion*

The focus group participants were keen users of smartphones and open to the sorts of functionality presented to them, including the most "extreme" version, the personalised chatbot. They were quick to see the potential of mobile apps for fitness and weight loss, but interestingly, for women to share their experiences with a weight loss app was seen as unnecessary and uncomfortable. No new factors emerged from the discussion, but the

importance of the Social Influence factor, with its many aspects – parental control, shaming and gender issues, was underlined.

### 4.3.3. Questionnaire Study

This section describes the main research instrument, the questionnaire, which targeted both users and non-users of mobile health apps in a population of young Saudi Arabians. In the previous chapter we described the development of the questionnaire. Here we describe its delivery and analysis.

#### *4.3.3.1 Questionnaire delivery*

In order to access the target participants and provide a convenient method for them to provide responses, a Web-based survey was employed. Web-based survey was selected as the most appropriate data collection method for this research study. The online questionnaire was built with survey tool Survey Monkey. Before it was published, the questionnaire was translated to Arabic by the researcher and a colleague. The questionnaire was pre-tested to make sure that the questions were understood clearly and answered within the planned time frame.

The data collection process lasted three months from January to March 2016. Participants were targeted by several approaches. Firstly, the researcher distributed the online questionnaire on the Ministry of Education website and universities website, encouraging university staff to ask their students to do it if they were willing to participate. This was possible because the researcher was a member of staff of a Saudi University. Secondly, the researcher made private contact via Facebook, Twitter, email and LinkedIn, using his own existing accounts. As co-ordinator of an online community for Saudi students in the University of Brighton, the researcher was well placed to make these links.

#### *4.3.3.2 Data Analysis*

The study tests the proposed framework UTAUT2 within mobile applications for health context. All the constructs proposed by Venkatesh et al. 2012 were adjusted for this research purpose and the three other factors were operationalized using different studies. This is described in detail in Chapter Three. To test the fit of the proposed model, the data retrieved from the questionnaire responses was recoded into numerical values with each response

corresponding to particular value. The data was encoded in the Software Statistical Package for Social Sciences (SPSS) for a number of statistical analyses, which will be explained in Chapter Five. Free text comments were translated and analysed thematically.

## 4.4. Ethical Considerations

In this research study, ethical issues were considered during the planning and the research process to ensure the integrity of research. In accordance with this, Brighton University requires all projects involving human subjects must have approval from the University's Research Ethics Committee before conducting the fieldwork. According to the University's Ethics Policy Guidelines, the researcher is required to fill in the Ethics Form, which must be signed by researcher and approved by the research student's supervisor.

In conformity with the ethics requirements, a covering letter was also attached with the questionnaire and focus group stating the purpose of the study. The name and the address of the researcher, and his university were included in the covering letter to increase respondents' confidence and to ensure respondents knew with whom they were dealing (Cooper and Schindler, 2001).

Privacy was an important issue, as with any questionnaire study. The respondents' information was kept confidential and they were not described in any way that allows them to be identified. To maintain the confidentiality and privacy of the respondents, only aggregate results were used in reporting results of this study. Participant's personal information was not been identified in any of the study findings. In addition, the data collected were not been used for any purpose other than as stated in the study objectives, which were only aimed for academic research for fulfilment of the requirements of a PhD thesis.

Personal discomfort was also a potential problem, for two reasons. Firstly, as explored above, the mixing of genders was a constant issue and we had to compromise by interviewing Saudi students in the UK rather than in Saudi Arabia. We do not believe this had a strong impact on the results of the focus group. However, in any future studies, it would probably be preferable to accept the status quo and to arrange separate male and female sessions.

Secondly, body image is a sensitive issue, particularly in a mixed group, and again it may be that gender-specific groups might have yielded even more results. Nevertheless, we did find participants to be quite frank in their comments.

## 4.5. Conclusion

The aim of this chapter was to discuss the practical implementation of methods used in this study, with problems encountered and lessons learned. The major tool was an online questionnaire survey, supplemented by literature review and a focus group session. We encountered some problems in setting up the focus group but nevertheless useful insights were gleaned. In terms of the questionnaire, it would have been valuable to have enrolled a larger number of participants, but the questionnaire did demand effort from participants, who had no motivation other than good will to participate: we are satisfied that the numbers we did achieve are sufficient to generate robust results.

The next chapter present the results of the research stages, followed by a discussion.

# Chapter Five: Results and Analysis

This chapter covers the results of the quantitative survey carried out amongst the people regarding the mobile health care and sets out the outcomes of the statistical analyses, giving a summary of the data collection process, the analysis process and the significant findings.

## 5.1. Research variables

As explained in Chapter Two, this study is based on the Extended unified theory of acceptance and use of technology (UTAUT2) framework. It therefore explores those factors (Independent Variables) that affect intention to use, and continuation to use, fitness apps (Dependent variables). The independent variables for this study are Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, Hedonic Motivation, Price Value, and Habit. In addition, there are three other factors defined as independent variables (see section 2.4.3), which are Trust, Perceived Privacy Risks and Valuation of Health.

The dependent variables are Initial Usage Intention and Continuing Usage Intention. The demographic variables on which the data has been collected include, Gender, Age and educational qualification of participants. Questionnaire was designed and used to collect data on the ten independent variables and three further variables. To test the reliability of the items used in this study, Cronbach's alpha was carried out. Cronbach's alpha is a measure of internal consistency, that is, how closely related a set of items are as a group. It is considered to be a measure of scale reliability.

To analyse the data, SPSS software was used to test the correlations between factors in order to test the study hypotheses (see section 3.3.1.1). To highlight the correlations between factors, the Pearson correlation test was used. Factor analysis was carried out to test that all items are loaded together. In order to test the effects of certain predictors independent of the influence of others, i.e.to test the fit of the two models, Extended unified theory of acceptance and use of

technology (UTAUT2) and its proposed extension, Hierarchical Regression was used.

| Independent variables | Moderating variables | Dependent variables |
|---|---|---|
| 1. Performance Expectancy<br>2. Effort Expectancy<br>3. Social Influence<br>4. Facilitating Conditions<br>5. Hedonic Motivation<br>6. Price Value<br>7. Habit<br>8. Trust<br>9. Perceived Privacy Risks<br>10. Valuation of Health | 1. Age<br>2. Gender<br>3. Education | 1. Initial Usage Intention<br>2. Continuing intention to use |

Table 5.1 Study Variables

## 5.2. Sample composition

The tables below describe the personal characteristics of the questionnaire respondents, i.e. age, gender and educational level.

| | Numbers | Per cent |
|---|---|---|
| 25 or less | 42 | 14.4 |
| 26-40 | 187 | 64.0 |
| 41-55 | 48 | 16.4 |
| 56 or more | 2 | 0.7 |
| Total | 279 | 95.5 |

Table 5.2 Sample – Age profile

Almost 78% of the respondents were in the age group up to 40 years, and this could be due to convenient sampling being used for selecting the respondents Note: In table 5.2, per cent total was 95.5, this indicates that there was a non-

response to the questionnaires. In total, 292 responses were received and analysed.

| | Numbers | Per cent |
|---|---|---|
| Male | 226 | 77.4 |
| Female | 53 | 18.2 |
| Total | 279 | 95.5 |

Table 5.3 Sample – Gender profile

Almost 77% of respondents were male, possibly because of cultural reasons, i.e. female potential respondents felt unable to respond to the questionnaire, despite the fact that it was delivered via Internet and did not involve interaction with males. It is *not* a reflection of the gender makeup of the Saudi student body, as there are slightly more female than male students in the country: according to the Saudi Ministry of Education, Saudi women constitute 51.8 per cent of Saudi university students. There are 551,000 women studying bachelor's degrees as compared to 513,000 men (Alarabiya.net).

| | Numbers | Per cent |
|---|---|---|
| No Education | 1 | 0.3 |
| Some high school | 40 | 13.7 |
| Diploma | 25 | 8.6 |
| Bachelor’s degree | 129 | 44.2 |
| Master’s degree | 66 | 22.6 |
| Doctorate degree | 16 | 5.5 |
| Total | 277 | 94.9 |

Table 5.4 Sample – education level profile

It can be seen that there is a high percentage of respondents with bachelor’s degrees, at 44.2% of the whole sample, as opposed to the national average of 26% in this age group (OECD, 2014). This is no doubt due to the fact that universities were used to distribute the survey. While only 23% of the entire population have university degrees (see Figure 5.1), most of these are in younger age categories. As shown in Figure 5.2, approximately 73 per cent of Saudi citizens in the age group 25-44 possess a university degree, indicating a

remarkably high level of demand and access to higher education. Thus, it is not surprising to find that younger respondents tend to have university level qualifications. However, it would have been valuable to have discovered where the attitudes of the University-educated population are mirrored by those of less well-educated young people. This is a limitation of the study, which could be extended in future work.

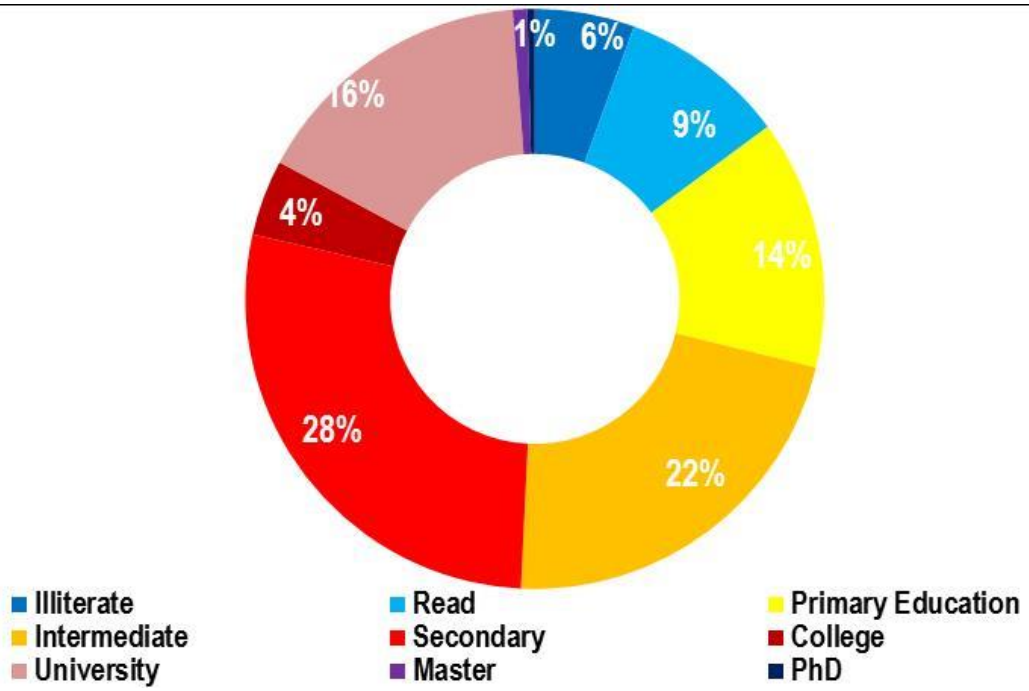



Figure 5.1 Population of Saudi Arabia by educational status (oryxsa.com, 2017)

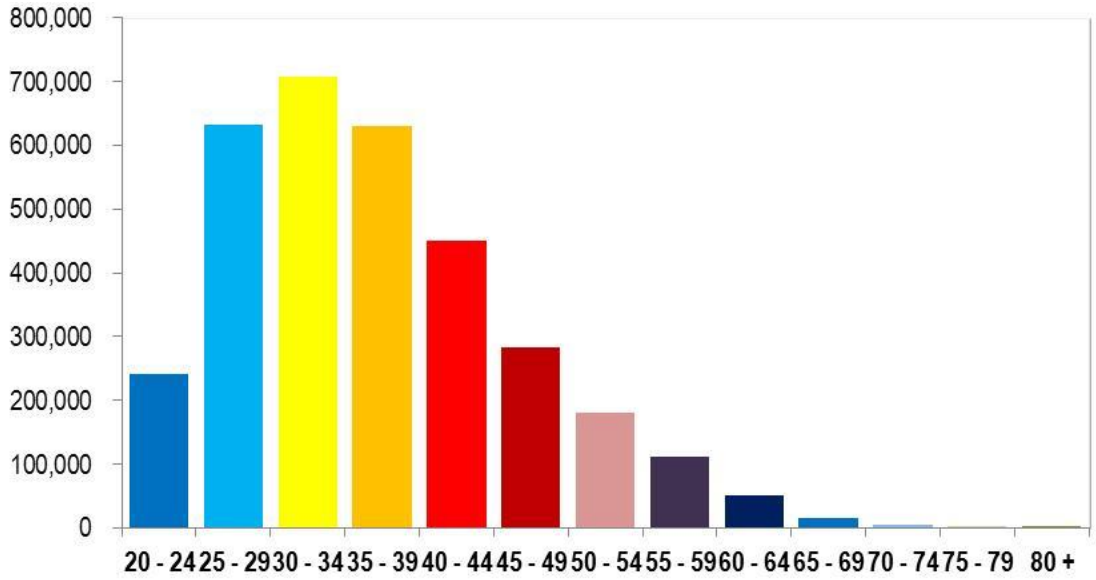



Figure 5.2 University Educated Population by Age Group (oryxsa.com, 2017)

## 5.3. Descriptive analysis across demographic variables

Demographic variables were investigated for their possible influence on usage intention. Three demographical variables were included in this research (Age, Gender and Education), as they have previously been shown to have an impact on behavioural intention. The section below gives a descriptive understanding of the impact of the demographical variables. A t-test was carried out to find out the mean value across gender groups. Generally t test is used to determine whether there is a significant difference between the means of males and females groups. A one-way ANOVA test was used to analyse results for the age group and educational level. The one-way analysis of variance (ANOVA) is used to determine whether there are any statistically significant differences between the means of two or more independent (unrelated) groups.

### 5.3.1. Descriptive analysis across Genders for Users:

A t-test was used to compare mean scores according to gender for the 100 respondents who already use fitness apps, of whom 22 were female and 78 male. We have set up the null hypothesis $(H_0)$ that the mean scores of male and female groups are identical for Users vs. alternative hypothesis $(H_a)$ that the mean scores of male and female groups are not identical.

| Descriptives For Fitness Apps Users | | | | | |
|---|---|---|---|---|---|
| | | N | Mean | Std. Deviation | Sig. |
| UserPE | Male | 78 | 3.827 | 0.996 | 0.113 |
| | Female | 22 | 4.182 | 0.552 | |
| | Total | 100 | 3.905 | 0.926 | |
| UserEE | Male | 78 | 3.863 | 0.890 | 0.052 |
| | Female | 22 | 4.261 | 0.638 | |
| | Total | 100 | 3.949 | 0.855 | |
| UserSIF | Male | 78 | 2.883 | 1.029 | 0.507 |
| | Female | 22 | 2.710 | 1.323 | |
| | Total | 100 | 2.845 | 1.096 | |
| UserSIS | Male | 78 | 2.840 | 1.018 | 0.761 |
| | Female | 22 | 2.917 | 0.960 | |
| | Total | 100 | 2.855 | 1.002 | |
| UserFC | Male | 78 | 3.582 | 0.813 | 0.102 |
| | Female | 22 | 3.886 | 0.549 | |
| | Total | 100 | 3.649 | 0.772 | |
| UserHM | Male | 78 | 3.524 | 0.943 | 0.048 |
| | Female | 22 | 3.983 | 0.776 | |
| | Total | 100 | 3.619 | 0.927 | |
| UserPV | Male | 78 | 3.642 | 0.853 | 0.483 |
| | Female | 22 | 3.783 | 0.820 | |
| | Total | 100 | 3.673 | 0.844 | |
| UserHbit | Male | 78 | 3.125 | 1.014 | 0.238 |
| | Female | 22 | 3.402 | 0.872 | |
| | Total | 100 | 3.188 | 0.986 | |
| UserTrust | Male | 78 | 3.632 | 0.847 | 0.487 |
| | Female | 22 | 3.768 | 0.721 | |
| | Total | 100 | 3.663 | 0.819 | |
| UserPriv | Male | 78 | 3.062 | 1.108 | 0.872 |
| | Female | 22 | 3.104 | 1.028 | |
| | Total | 100 | 3.072 | 1.086 | |
| UserHV | Male | 78 | 4.443 | 0.798 | 0.660 |
| | Female | 22 | 4.522 | 0.538 | |
| | Total | 100 | 4.462 | 0.743 | |
| UserCU | Male | 78 | 3.485 | 0.950 | 0.244 |
| | Female | 22 | 3.739 | 0.772 | |
| | Total | 100 | 3.542 | 0.915 | |

Table 5.6 Gender-based results for app users

Table 5.6 shows that male and female users' scores are very similar, but female participants had higher mean values for all except one factor compared with male participants. The $p$-value is more than the level of significance $(\alpha)$ for all male and female users scores, so accept the null hypothesis $(H_0)$ or in other words the data does not provide enough evidence to support the alternative hypothesis $(H_a)$. We may conclude with 95% confidence interval that mean scores of male and female groups are identical. However it is not significant at 5% level of significance.

This could be read as a general overall enthusiasm for apps among female respondents. The one factor where males scored slightly higher was Social Influence of friends and family, perhaps slightly surprising in a society where women are very constrained by social influence compared to men.

### 5.3.2. Descriptive analysis across Genders for Non-Users:

Similarly, a t-test is used to compare means in between gender groups for Non Users. We have set up the null hypothesis $(H_0)$ that the mean scores for gender groups are identical vs. alternative hypothesis $(H_a)$ that the mean scores for gender groups are not identical. The table below shows that the gender groups who use fitness apps have agreed or strongly agreed for all variables. Table 5.7 below indicates that the male participants had higher mean values for Performance Expectancy, Effort Expectancy, Social influence (friends and family), Facilitating Conditions, Price Value, Habit, Trust and Continued Usage Intention compared with female participants. On the other hand the female participants had higher mean values for Social influence of healthcare professionals, Hedonic Motivation, Privacy and Health valuation. The $p$-value is more than the level of significance $(\alpha)$ for all male and female Non Users scores, so accept the null hypothesis $(H_0)$ or in other words, we fail to reject null hypothesis $(H_0)$. We may conclude with 95% confidence interval that mean scores of male and female groups are identical. However, it is not significant at 5% level of significance.

| Descriptives For Fitness Apps NonUsers | | | | | |
|---|---|---|---|---|---|
| | | N | Mean | Std. Deviation | Sig. |
| NoNUserPE | Male | 94 | 3.830 | 0.909 | 0.332 |
| | Female | 17 | 3.603 | 0.718 | |
| | Total | 111 | 3.795 | 0.883 | |
| NoNUserEE | Male | 94 | 3.909 | 0.806 | 0.278 |
| | Female | 17 | 3.676 | 0.814 | |
| | Total | 111 | 3.873 | 0.808 | |
| NoNUserSIF | Male | 94 | 3.301 | 1.036 | 0.292 |
| | Female | 17 | 3.020 | 0.820 | |
| | Total | 111 | 3.258 | 1.007 | |
| NoNUserSIS | Male | 94 | 3.738 | 0.812 | 0.755 |
| | Female | 17 | 3.804 | 0.688 | |
| | Total | 111 | 3.748 | 0.791 | |
| NoNUserFC | Male | 94 | 3.758 | 0.752 | 0.277 |
| | Female | 17 | 3.544 | 0.686 | |
| | Total | 111 | 3.725 | 0.743 | |
| NoNUserHM | Male | 94 | 3.623 | 0.937 | 0.794 |
| | Female | 17 | 3.686 | 0.759 | |
| | Total | 111 | 3.633 | 0.908 | |
| NoNUserPV | Male | 94 | 3.615 | 1.089 | 0.358 |
| | Female | 17 | 3.353 | 0.975 | |
| | Total | 111 | 3.573 | 1.072 | |
| NoNUserHabit | Male | 94 | 3.367 | 0.927 | 0.631 |
| | Female | 17 | 3.250 | 0.857 | |
| | Total | 111 | 3.348 | 0.913 | |
| NoNUserTrust | Male | 94 | 3.600 | 0.951 | 0.386 |
| | Female | 17 | 3.392 | 0.568 | |
| | Total | 111 | 3.567 | 0.902 | |
| NoNUserPrivc | Male | 94 | 3.061 | 1.199 | 0.601 |
| | Female | 17 | 3.224 | 1.029 | |
| | Total | 111 | 3.087 | 1.170 | |
| NoNUserHV | Male | 94 | 3.407 | 0.629 | 0.592 |
| | Female | 17 | 3.494 | 0.485 | |
| | Total | 111 | 3.422 | 0.606 | |
| NoNUserInToUse | Male | 94 | 3.581 | 0.930 | 0.026 |
| | Female | 17 | 3.039 | 0.781 | |
| | Total | 111 | 3.495 | 0.926 | |

Table 5.7 Gender-based results for app Non Use

### 5.3.3. Descriptive analysis across Age groups for Users of Fitness Apps

A One-Way ANOVA test was used to compare means in between age groups. A comparison of mean values of age groups on continuing usage intention showed that the age group of 25 years or less showed the highest mean value with (m= 3.741) followed by the 26-40 age group with mean value (m=3.398) then age group of 41-55 with mean value (m= 3.208). The $p$-value is more than the level of significance $(\alpha)$ for all age groups, so accept the null hypothesis $(H_0)$ or in other words the data does not provide enough evidence to support the alternative hypothesis $(H_a)$. We may conclude with 95% confidence interval that mean scores of all age groups are identical. However, it is not significant at 5% level of significance. The Table 5.8 below shows that the age groups that use fitness apps have agreed or strongly agreed for all variables apart from Social Influence.

Interestingly, users of fitness apps across age groups have low scores on the Privacy questions, perhaps indicating that once they own an app their initial worries are soothed.

In addition, younger respondents show a slightly higher level of health valuation than older users. We will see that this is the opposite of the score on this variable for non-users. This could indicate that young people concerned with fitness may already be turning to mHealth apps. These differences are not enough to be significant, but may indicate that the issue of the individual's thinking about his/her own health is a path worth exploring in more detail in further work. .

| Descriptive analysis across age groups for User | | | | | |
|---|---|---|---|---|---|
| | | N | Mean | Std. Deviation | Sig. |
| UserPEmean | 25 or less | 9 | 4.028 | 0.805 | 0.607 |
| | 26-40 | 67 | 3.847 | 0.939 | |
| | 41-55 | 8 | 3.563 | 1.314 | |
| | Total | 84 | 3.839 | 0.960 | |
| UserEEmean | 25 or less | 9 | 3.861 | 0.945 | 0.79 |
| | 26-40 | 67 | 3.910 | 0.835 | |
| | 41-55 | 8 | 3.688 | 1.108 | |
| | Total | 84 | 3.884 | 0.865 | |
| UserSIFmean | 25 or less | 9 | 2.667 | 1.443 | 0.696 |
| | 26-40 | 67 | 2.766 | 1.035 | |
| | 41-55 | 8 | 3.083 | 1.109 | |
| | Total | 84 | 2.786 | 1.080 | |
| UserSISmean | 25 or less | 9 | 3.000 | 1.179 | 0.837 |
| | 26-40 | 67 | 2.871 | 0.990 | |
| | 41-55 | 8 | 2.708 | 0.933 | |
| | Total | 84 | 2.869 | 0.995 | |
| UserFCmean | 25 or less | 9 | 3.417 | 0.857 | 0.635 |
| | 26-40 | 67 | 3.646 | 0.756 | |
| | 41-55 | 8 | 3.750 | 0.791 | |
| | Total | 84 | 3.631 | 0.765 | |
| UserHMmean | 25 or less | 9 | 3.556 | 0.943 | 0.722 |
| | 26-40 | 67 | 3.577 | 0.937 | |
| | 41-55 | 8 | 3.292 | 1.015 | |
| | Total | 84 | 3.548 | 0.937 | |
| UserPVmean | 25 or less | 9 | 3.481 | 0.709 | 0.544 |
| | 26-40 | 67 | 3.587 | 0.890 | |
| | 41-55 | 8 | 3.917 | 0.886 | |
| | Total | 84 | 3.607 | 0.869 | |
| UserHbitmean | 25 or less | 9 | 3.333 | 1.068 | 0.63 |
| | 26-40 | 67 | 3.090 | 0.925 | |
| | 41-55 | 8 | 2.875 | 1.356 | |
| | Total | 84 | 3.095 | 0.978 | |
| UserTrusmean | 25 or less | 9 | 3.667 | 0.972 | 0.821 |
| | 26-40 | 67 | 3.577 | 0.795 | |
| | 41-55 | 8 | 3.417 | 1.004 | |
| | Total | 84 | 3.571 | 0.826 | |
| UserPrivmean | 25 or less | 9 | 2.933 | 1.082 | 0.833 |
| | 26-40 | 67 | 2.994 | 1.084 | |
| | 41-55 | 8 | 2.750 | 1.165 | |
| | Total | 84 | 2.964 | 1.080 | |
| UserHVmean | 25 or less | 9 | 4.528 | 0.870 | 0.898 |
| | 26-40 | 67 | 4.504 | 0.747 | |
| | 41-55 | 8 | 4.375 | 0.916 | |
| | Total | 84 | 4.494 | 0.767 | |
| UserCUmean | 25 or less | 9 | 3.741 | 0.846 | 0.470 |
| | 26-40 | 67 | 3.398 | 0.914 | |
| | 41-55 | 8 | 3.208 | 1.140 | |
| | Total | 84 | 3.417 | 0.927 | |

Table 5.8 Age groups results for app users

### 5.3.4. Descriptive analysis across age groups for Non-Users of Fitness Apps

Similarly for app Non Users, we set up the null hypothesis $(H_0)$ that there is no mean difference among the age groups vs. alternative hypothesis $(H_a)$ there is a difference. For this purpose a one-way ANOVA was used to compare means between age groups. The table 5.9 below shows that the age groups who do not use fitness apps have agreed or strongly agreed for all variables. A comparison of mean values of age groups on initial usage intention showed that the age group of 25 years or less showed the highest mean value with (m= 3.604) followed by the age group of 41-55 with mean value (m=3.551) then age group of 26-40 with mean value (m= 3.446). So from the table 5.9 we can see that the $p$-value is more than the level of significance $(\alpha)$ for all age groups, so accept the null hypothesis $(H_0)$ or in other words the data does not provide enough evidence to support the alternative hypothesis $(H_a)$. We may conclude with 95% confidence interval that mean scores of all age groups are identical. However, it is not significant at 5% level of significance. There is therefore no significant difference among age groups in the study, which is unsurprising considering that the age range studied is deliberately restricted, i.e. middle aged and older people were not surveyed.

| Descriptive analysis across age groups for NonUser | | | | | |
|---|---|---|---|---|---|
| | | N | Mean | Std. Deviation | Sig. |
| NoNUserPE | 25 or less | 18 | 3.903 | 1.044 | 0.654 |
| | 26-40 | 66 | 3.731 | 0.884 | |
| | 41-55 | 27 | 3.880 | 0.779 | |
| | Total | 111 | 3.795 | 0.883 | |
| NoNUserEE | 25 or less | 18 | 3.889 | 0.908 | 0.840 |
| | 26-40 | 66 | 3.902 | 0.864 | |
| | 41-55 | 27 | 3.795 | 0.601 | |
| | Total | 111 | 3.873 | 0.808 | |
| NoNUserSIF | 25 or less | 18 | 3.333 | 1.021 | 0.485 |
| | 26-40 | 66 | 3.164 | 1.031 | |
| | 41-55 | 27 | 3.429 | 0.951 | |
| | Total | 111 | 3.258 | 1.007 | |
| NoNUserSIS | 25 or less | 18 | 3.741 | 0.940 | 0.881 |
| | 26-40 | 66 | 3.723 | 0.828 | |
| | 41-55 | 27 | 3.815 | 0.594 | |
| | Total | 111 | 3.748 | 0.791 | |
| NoNUserFC | 25 or less | 18 | 3.708 | 0.824 | 0.773 |
| | 26-40 | 66 | 3.692 | 0.810 | |
| | 41-55 | 27 | 3.813 | 0.507 | |
| | Total | 111 | 3.725 | 0.743 | |
| NoNUserHM | 25 or less | 18 | 3.686 | 0.982 | 0.903 |
| | 26-40 | 66 | 3.601 | 0.938 | |
| | 41-55 | 27 | 3.679 | 0.808 | |
| | Total | 111 | 3.633 | 0.908 | |
| NoNUserPV | 25 or less | 18 | 3.542 | 0.973 | 0.563 |
| | 26-40 | 66 | 3.503 | 1.196 | |
| | 41-55 | 27 | 3.769 | 0.765 | |
| | Total | 111 | 3.573 | 1.072 | |
| NoNUserHabit | 25 or less | 18 | 3.531 | 0.961 | 0.498 |
| | 26-40 | 66 | 3.266 | 0.989 | |
| | 41-55 | 27 | 3.435 | 0.671 | |
| | Total | 111 | 3.348 | 0.913 | |
| NoNUserTrust | 25 or less | 18 | 3.646 | 0.939 | 0.324 |
| | 26-40 | 66 | 3.464 | 0.991 | |
| | 41-55 | 27 | 3.765 | 0.598 | |
| | Total | 111 | 3.567 | 0.902 | |
| NoNUserPrivc | 25 or less | 18 | 3.275 | 1.224 | 0.251 |
| | 26-40 | 66 | 2.934 | 1.246 | |
| | 41-55 | 27 | 3.346 | 0.888 | |
| | Total | 111 | 3.087 | 1.170 | |
| NoNUserHV | 25 or less | 18 | 3.253 | 0.735 | 0.242 |
| | 26-40 | 66 | 3.400 | 0.628 | |
| | 41-55 | 27 | 3.576 | 0.429 | |
| | Total | 111 | 3.422 | 0.606 | |
| NoNUserInToUse | 25 or less | 18 | 3.604 | 0.952 | 0.782 |
| | 26-40 | 66 | 3.446 | 0.979 | |
| | 41-55 | 27 | 3.551 | 0.788 | |
| | Total | 111 | 3.495 | 0.926 | |

Table 5.9 Age groups results for app non-users

## 5.4. Relation between Independent Factors and Dependent Factors

Exploring the relationships between variables is the foundation of most quantitatively based research. There are many techniques to show the relationships between factors or variables. In this study, Pearson's correlation technique has been used to show the relationships between independent factors and dependent factors. Pearson's correlation technique is a measure of linear dependence between two variables, X and Y, giving a value between +1 (total positive correlation) and -1 (total negative correlation). Table 5.10 recaps the Independent Factors and Dependent Factors explored in the research.

| Independent variables | Dependent variables |
|---|---|
| Performance Expectancy | Initial Usage Intention<br>Continued Usage Intention |
| Effort Expectancy | |
| Social Influence | |
| Facilitating Conditions | |
| Hedonic Motivation | |
| Price Value | |
| Habit | |
| Trust | |
| Perceived Privacy Risks | |
| Valuation of Health | |

Table 5.10 Independent and dependent variables recap

### 5.4.1 Relation between Factors and Continued Usage Intention

Table 5.11 below shows the relationships between independent variables and the dependent variables. Here the correlation is tested for *users* of fitness apps so the relevant dependent variable will be Continued Usage Intention.

The Pearson correlation coefficient (PCC) values in the tables confirm that there are positive correlations between independent variables and the dependent variable. Most values are above 0.4, which means the positive correlations are strong. The exception is the correlation between HV (health valuation) with CU (Continued Usage Intention), which is 0.201, considered a weak positive correlation. This could mean that actual use of fitness apps has been

disappointing to users, who do not believe that continued use will support them in a healthy lifestyle.

Habit correlates strongly with continued intention to use, as could be predicted. Perceived Effectiveness and Trust scores are both high, suggesting that there may be some overlap: someone who believes the app to be effective will also trust its quality. Social influence scores are not particularly high, though the influence of friends and family is stronger than that of the health profession, as again was predicted for this population.

**Correlations for User Model**

| | PEuser | EEuser | SIFuser | SISuser | FCuser | HMuser | PVuser | Huser | Truser | Privuser | HVuser | CUuser |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PEuser** | | | | | | | | | | | | |
| **EEuser** | .606** | | | | | | | | | | | |
| **SIFuser** | .494** | .289** | | | | | | | | | | |
| **SISuser** | .300** | 0.185 | .485** | | | | | | | | | |
| **FCuser** | .677** | .612** | .611** | .422** | | | | | | | | |
| **HMuser** | .552** | .607** | .443** | .349** | .564** | | | | | | | |
| **PVuser** | .419** | .449** | .348** | .199* | .532** | .379** | | | | | | |
| **Huser** | .598** | .391** | .465** | .523** | .514** | .414** | .296** | | | | | |
| **Truser** | .695** | .625** | .575** | .445** | .659** | .655** | .529** | .652** | | | | |
| **Privuser** | .206* | 0.104 | .305** | .292** | .239* | .304** | 0.041 | .404** | .292** | | | |
| **HVuser** | .399** | .297** | 0.068 | 0.099 | .368** | .259* | .332** | 0.065 | .293** | 0.01 | | |
| **CUuser** | .636** | .458** | .498** | .362** | .600** | .563** | .410** | .757** | .755** | .389** | .201* | |

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 5.11 Correlation between factors and continued usage intention

### 5.4.2 The Relation between Factors and Initial Usage Intention

Table 5.12 indicates that the correlation between independent variables and dependent variables for non-users of fitness apps are mainly positive, at a level of 0.4. The exceptions are Privacy concerns and Health Valuation, which both show very low correlations. There are some interesting differences between user and non-user results. In terms of Social Influence, these non-users rate the influence of the medical profession more highly than that of friends and family: perhaps these respondents may be non-users of mHealth apps because they are not strongly endorsed by the medical profession at the moment.

| Correlations for Non-User Model | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Factors** | PE | EE | SIF | SIS | FC | HM | PriceValue | Habit | Trust | Privacy | HV | ITU |
| **PE** | | | | | | | | | | | | |
| **EE** | .581** | | | | | | | | | | | |
| **SIF** | .510** | .535** | | | | | | | | | | |
| **SIS** | .581** | .501** | .597** | | | | | | | | | |
| **FC** | .607** | .612** | .536** | .651** | | | | | | | | |
| **HM** | .504** | .531** | .565** | .550** | .599** | | | | | | | |
| **PriceValue** | .481** | .444** | .440** | .473** | .610** | .513** | | | | | | |
| **Habit** | .560** | .487** | .608** | .570** | .580** | .581** | .620** | | | | | |
| **Trust** | .625** | .457** | .585** | .587** | .543** | .628** | .499** | .548** | | | | |
| **PrivacyNon User** | 0.111 | 0.102 | .200* | 0.112 | 0.111 | 0.18 | .235* | 0.118 | .287** | | | |
| **HV** | 0.168 | .363** | 0.16 | .268** | .249* | .354** | 0.097 | 0.053 | .211* | 0.091 | | |
| **ITU** | .708** | .462** | .479** | .541** | .537** | .523** | .523** | .676** | .657** | 0.164 | 0.141 | |
| ****. Correlation is significant at the 0.01 level (2-tailed).** | | | | | | | | | | | | |
| ***. Correlation is significant at the 0.05 level (2-tailed).** | | | | | | | | | | | | |

Table 5.12 Correlation between factors and initial usage intention

They are more confident of the efficacy of the apps than users, but with an equivalent notion of app ease of use. However, unlike current users, they have concerns about the privacy of their data. The correlation with intention to adopt and health valuation is surprisingly low. The results seem to be suggesting that respondents are willing to try the app out of curiosity, without having many current concerns for their own health.

## 5.5. Factor Analysis:

Factor analysis is used when a number of questions have been written to measure one item, to find out if all questions for each item are loading together and have positive correlations.

### 5.5.1. Factor Analysis for Users of fitness Apps

The first step of factor analysis is to make sure that the data set is appropriate to conduct factor analysis. This can be done by using Kaiser-Meyer-Olkin (KMO). KMO measures more than 0.6 are considered suitable for factor analysis (Ferguson & Cox, 1993). In this part, the KMO measure of user of fitness apps was 0.822.

| | | |
|---|---|---|
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy. | | 0.822 |
| Bartlett's Test of Sphericity | Approx. Chi-Square | 3993.002 |
| | df | 903 |
| | Sig. | 0.000 |

Table 5.13 KMO measures for apps users

Next, the rotated components matrix shows if all questions that have been asked for each item are loaded together in one factor. Table 5.14 below shows that the items intended to test each construct are loaded together, which means that we do not need to delete any question or item in any further test.

| Rotated Component Matrix[a] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Component | | | | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| UserPE1 | | | | | | 0.635 | | | |
| UserPE2 | | | | | | 0.685 | | | |
| UserPE3 | | | | | | 0.733 | | | |
| UserPE4 | | | | | | 0.679 | | | |
| UserEE1 | | 0.820 | | | | | | | |
| UserEE2 | | 0.840 | | | | | | | |
| UserEE3 | | 0.875 | | | | | | | |
| UserEE4 | | 0.720 | | | | | | | |
| UserSIF1 | | | | | 0.774 | | | | |
| UserSIF2 | | | | | 0.772 | | | | |
| UserSIF3 | | | | | 0.790 | | | | |
| UserSIS1 | | | | | | | | 0.709 | |
| UserSIS2 | | | | | | | | 0.780 | |
| UserSIS3 | | | | | | | | 0.833 | |
| UserFC1 | | | | | 0.462 | | | | |
| UserFC2 | | | | | 0.365 | | | | |
| UserFC3 | | | | | 0.426 | | | | |
| UserFC4 | | | | | 0.463 | | | | |
| UseHM1 | | | | | | | 0.785 | | |
| UseHM2 | | | | | | | 0.792 | | |
| UseHM3 | | | | | | | 0.832 | | |
| UserPV1 | | | | | | | | | 0.897 |
| UserPV2 | | | | | | | | | 0.856 |
| UserPV3 | | | | | | | | | 0.644 |
| UserH1 | 0.741 | | | | | | | | |
| UserH2 | 0.700 | | | | | | | | |
| UserH3 | 0.631 | | | | | | | | |
| UserH4 | 0.784 | | | | | | | | |
| UserInTo Use1 | 0.720 | | | | | | | | |
| UserInTo Use2 | 0.700 | | | | | | | | |
| UserInTo Use3 | 0.760 | | | | | | | | |
| UserTru1 | 0.630 | | | | | | | | |
| UserTru2 | 0.514 | | | | | | | | |
| UserTru3 | 0.510 | | | | | | | | |
| UserPriv1 | | | 0.843 | | | | | | |
| UserPriv2 | | | 0.926 | | | | | | |
| UserPriv3 | | | 0.879 | | | | | | |
| UserPriv4 | | | 0.936 | | | | | | |
| UserPriv5 | | | 0.912 | | | | | | |
| UserHV1 | | | | 0.868 | | | | | |
| UserHV2 | | | | 0.935 | | | | | |
| UserHV3 | | | | 0.950 | | | | | |
| UserHV4 | | | | 0.955 | | | | | |

Extraction Method: Principal Component Analysis.

a. Rotation converged in 8 iterations.

Table 5.14 Rotated components matrix for apps users.

Total variance is used to test the Eigen value to see the cumulative percentage of the number of factors that explain the total variance. In the results for app users, this was measured to show that nine factors explain 81% of the variance.

**Total Variance Explained for user of fitness Apps**

| Component | Initial Eigenvalues | | | Loadings | | | Loadings | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1 | 16.365 | 38.059 | 38.059 | 16.365 | 38.059 | 38.059 | 6.059 | 14.091 | 14.091 |
| 2 | 5.276 | 12.269 | 50.328 | 5.276 | 12.269 | 50.328 | 4.746 | 11.038 | 25.129 |
| 3 | 3.295 | 7.663 | 57.991 | 3.295 | 7.663 | 57.991 | 4.503 | 10.471 | 35.600 |
| 4 | 2.345 | 5.453 | 63.444 | 2.345 | 5.453 | 63.444 | 4.182 | 9.725 | 45.325 |
| 5 | 1.852 | 4.307 | 67.751 | 1.852 | 4.307 | 67.751 | 3.601 | 8.376 | 53.701 |
| 6 | 1.772 | 4.121 | 71.871 | 1.772 | 4.121 | 71.871 | 3.215 | 7.477 | 61.178 |
| 7 | 1.581 | 3.677 | 75.548 | 1.581 | 3.677 | 75.548 | 3.076 | 7.155 | 68.332 |
| 8 | 1.327 | 3.086 | 78.635 | 1.327 | 3.086 | 78.635 | 2.983 | 6.938 | 75.270 |
| 9 | 1.051 | 2.443 | 81.078 | 1.051 | 2.443 | 81.078 | 2.497 | 5.808 | 81.078 |
| 10 | 0.847 | 1.970 | 83.048 | | | | | | |
| 11 | 0.799 | 1.857 | 84.905 | | | | | | |
| 12 | 0.704 | 1.638 | 86.543 | | | | | | |
| 13 | 0.602 | 1.400 | 87.943 | | | | | | |
| 14 | 0.528 | 1.227 | 89.170 | | | | | | |
| 15 | 0.502 | 1.168 | 90.338 | | | | | | |
| 16 | 0.488 | 1.134 | 91.473 | | | | | | |
| 17 | 0.435 | 1.013 | 92.485 | | | | | | |
| 18 | 0.353 | 0.821 | 93.306 | | | | | | |
| 19 | 0.332 | 0.772 | 94.078 | | | | | | |
| 20 | 0.245 | 0.571 | 94.649 | | | | | | |
| 21 | 0.232 | 0.540 | 95.188 | | | | | | |
| 22 | 0.220 | 0.512 | 95.700 | | | | | | |
| 23 | 0.212 | 0.494 | 96.194 | | | | | | |
| 24 | 0.188 | 0.437 | 96.631 | | | | | | |
| 25 | 0.173 | 0.403 | 97.033 | | | | | | |
| 26 | 0.161 | 0.375 | 97.408 | | | | | | |
| 27 | 0.136 | 0.316 | 97.725 | | | | | | |
| 28 | 0.129 | 0.301 | 98.025 | | | | | | |
| 29 | 0.109 | 0.255 | 98.280 | | | | | | |
| 30 | 0.100 | 0.232 | 98.512 | | | | | | |
| 31 | 0.092 | 0.215 | 98.727 | | | | | | |
| 32 | 0.088 | 0.206 | 98.932 | | | | | | |
| 33 | 0.070 | 0.162 | 99.095 | | | | | | |
| 34 | 0.067 | 0.156 | 99.251 | | | | | | |
| 35 | 0.066 | 0.153 | 99.404 | | | | | | |
| 36 | 0.056 | 0.131 | 99.534 | | | | | | |
| 37 | 0.050 | 0.115 | 99.650 | | | | | | |
| 38 | 0.037 | 0.086 | 99.736 | | | | | | |
| 39 | 0.032 | 0.074 | 99.810 | | | | | | |
| 40 | 0.031 | 0.072 | 99.882 | | | | | | |
| 41 | 0.023 | 0.054 | 99.936 | | | | | | |
| 42 | 0.015 | 0.034 | 99.970 | | | | | | |
| 43 | 0.013 | 0.030 | 100.000 | | | | | | |

Extraction Method: Principal Component Analysis.

Table 5.15 Total variance for apps users

### 5.5.2. Factor analysis for Non-users of fitness Apps

The KMO for non-users of fitness apps is 0.874 which means is appropriate to conduct factor analysis. The high Chi-square score confirms this.

| | | |
|---|---|---|
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy. | | 0.874 |
| Bartlett's Test of Sphericity | Approx. Chi-Square | 4272.963 |
| | df | 903 |
| | Sig. | 0.000 |

Table 5.16 KMO measures for app non-users

As explained above, the rotated components matrix shows if all questions that have been asked for each item are loaded together in one factor. Table 5.17 confirms that the questions for each construct are loaded together.

| Rotated Component Matrix[a] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Component | | | | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| PENONUser1 | 0.705 | | | | | | | | |
| PENONUser2 | 0.726 | | | | | | | | |
| PENONUser3 | 0.619 | | | | | | | | |
| PENONUser4 | 0.604 | | | | | | | | |
| EENonUser1 | | 0.687 | | | | | | | |
| EENonUser2 | | 0.799 | | | | | | | |
| EENonUser3 | | 0.807 | | | | | | | |
| EENonUser4 | | 0.791 | | | | | | | |
| SlNonUserFriends1 | | | | | | 0.707 | | | |
| SlNonUserFriends2 | | | | | | 0.731 | | | |
| SlNonUserFriends3 | | | | | | 0.677 | | | |
| SlNonUserSpicas1 | | | | | 0.593 | | | | |
| SlNonUserSpicas2 | | | | | 0.651 | | | | |
| SlNonUserSpicas3 | | | | | 0.738 | | | | |
| FCNonUser1 | | | | | 0.637 | | | | |
| FCNonUser2 | | | | | 0.619 | | | | |
| FCNonUser3 | | | | | 0.368 | | | | |
| FCNonUser4 | | | | | 0.277 | | | | |
| HMnonUser1 | | | | | | | | | 0.681 |
| HMnonUser2 | | | | | | | | | 0.584 |
| HMnonUser3 | | | | | | | | | 0.691 |
| PVnonUser1 | | | | | | | 0.785 | | |
| PVnonUser2 | | | | | | | 0.834 | | |
| PVnonUser3 | | | | | | | 0.628 | | |
| HnonUser1 | | | | | | | | 0.583 | |
| HnonUser2 | | | | | | | | 0.509 | |
| HnonUser3 | | | | | | | | 0.594 | |
| HnonUser4 | | | | | | | | 0.700 | |
| TrustnonUser1 | 0.618 | | | | | | | | |
| TrustnonUser2 | 0.623 | | | | | | | | |
| TrustnonUser3 | 0.607 | | | | | | | | |
| PrivcynonUser1 | | | 0.844 | | | | | | |
| PrivcynonUser2 | | | 0.945 | | | | | | |
| PrivcynonUser3 | | | 0.941 | | | | | | |
| PrivcynonUser4 | | | 0.918 | | | | | | |
| PrivcynonUser5 | | | 0.926 | | | | | | |
| HVnonUser1 | | | | 0.736 | | | | | |
| HVnonUser2 | | | | 0.834 | | | | | |
| HVnonUser3 | | | | 0.847 | | | | | |
| HVnonUser4 | | | | 0.791 | | | | | |
| ItoUsenonUser1 | 0.734 | | | | | | | | |
| ItoUsenonUser2 | 0.695 | | | | | | | | |
| ItoUsenonUser3 | 0.740 | | | | | | | | |

Extraction Method: Principal Component Analysis.

a. Rotation converged in 14 iterations.

Table 5.17 Rotated components matrix for app non-users

Again, nine factors explain 81% of variance:

**Total Variance Explained**

| Component | Initial Eigenvalues | | | Loadings | | | Loadings | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1 | 19.377 | 45.063 | 45.063 | 19.377 | 45.063 | 45.063 | 6.354 | 14.777 | 14.777 |
| 2 | 4.310 | 10.022 | 55.086 | 4.310 | 10.022 | 55.086 | 4.861 | 11.304 | 26.081 |
| 3 | 2.901 | 6.747 | 61.833 | 2.901 | 6.747 | 61.833 | 4.613 | 10.729 | 36.810 |
| 4 | 1.826 | 4.246 | 66.078 | 1.826 | 4.246 | 66.078 | 3.741 | 8.700 | 45.510 |
| 5 | 1.661 | 3.863 | 69.941 | 1.661 | 3.863 | 69.941 | 3.572 | 8.306 | 53.816 |
| 6 | 1.447 | 3.365 | 73.306 | 1.447 | 3.365 | 73.306 | 3.320 | 7.722 | 61.538 |
| 7 | 1.228 | 2.855 | 76.161 | 1.228 | 2.855 | 76.161 | 3.006 | 6.990 | 68.528 |
| 8 | 1.106 | 2.571 | 78.732 | 1.106 | 2.571 | 78.732 | 2.782 | 6.470 | 74.998 |
| 9 | 1.018 | 2.367 | 81.099 | 1.018 | 2.367 | 81.099 | 2.623 | 6.101 | 81.099 |
| 10 | 0.884 | 2.056 | 83.155 | | | | | | |
| 11 | 0.727 | 1.691 | 84.846 | | | | | | |
| 12 | 0.586 | 1.364 | 86.210 | | | | | | |
| 13 | 0.569 | 1.324 | 87.534 | | | | | | |
| 14 | 0.520 | 1.210 | 88.744 | | | | | | |
| 15 | 0.442 | 1.027 | 89.771 | | | | | | |
| 16 | 0.418 | 0.971 | 90.742 | | | | | | |
| 17 | 0.375 | 0.872 | 91.615 | | | | | | |
| 18 | 0.344 | 0.801 | 92.416 | | | | | | |
| 19 | 0.321 | 0.747 | 93.163 | | | | | | |
| 20 | 0.299 | 0.695 | 93.858 | | | | | | |
| 21 | 0.286 | 0.665 | 94.523 | | | | | | |
| 22 | 0.258 | 0.601 | 95.124 | | | | | | |
| 23 | 0.240 | 0.558 | 95.682 | | | | | | |
| 24 | 0.222 | 0.517 | 96.199 | | | | | | |
| 25 | 0.181 | 0.422 | 96.621 | | | | | | |
| 26 | 0.170 | 0.394 | 97.015 | | | | | | |
| 27 | 0.150 | 0.348 | 97.363 | | | | | | |
| 28 | 0.132 | 0.307 | 97.671 | | | | | | |
| 29 | 0.123 | 0.286 | 97.957 | | | | | | |
| 30 | 0.111 | 0.258 | 98.215 | | | | | | |
| 31 | 0.101 | 0.234 | 98.449 | | | | | | |
| 32 | 0.096 | 0.224 | 98.673 | | | | | | |
| 33 | 0.090 | 0.208 | 98.881 | | | | | | |
| 34 | 0.075 | 0.173 | 99.055 | | | | | | |
| 35 | 0.069 | 0.159 | 99.214 | | | | | | |
| 36 | 0.060 | 0.139 | 99.354 | | | | | | |
| 37 | 0.057 | 0.133 | 99.487 | | | | | | |
| 38 | 0.053 | 0.123 | 99.610 | | | | | | |
| 39 | 0.047 | 0.109 | 99.719 | | | | | | |
| 40 | 0.037 | 0.087 | 99.806 | | | | | | |
| 41 | 0.036 | 0.085 | 99.890 | | | | | | |
| 42 | 0.028 | 0.065 | 99.956 | | | | | | |
| 43 | 0.019 | 0.044 | 100.000 | | | | | | |

Extraction Method: Principal Component Analysis.

Table 5.18 Total variance for app non-user

## 5.6. Hierarchical Regression on Usage Intention Factors

### 5.6.1. Hierarchical Regression for users of fitness apps

In order to test the effects of certain predictors independent of the influence of others, linear regression has been used. This is "a way to show if variables of your interest explain a statistically significant amount of variance in your Dependent Variable (DV) after accounting for all other variables. This is a framework for model comparison rather than a statistical method" (University of Virginia, 2017). One of the objectives of this study was to determine whether the three newly added variables, trust, privacy and health valuation, show a significant improvement in $R2$ (the proportion of explained variance in DV by the model).

The UTAUT2 framework's variables were entered and then the other three factors that have been added to the proposed model entered to compare $R2$ with and without the additional variables. **Importantly, the change in the $R2$ (as shown in the tables below) indicates how much predictive power was added to the model by the addition of another variable**. From Table 5.20 we may conclude that $p$- value is less than 5% level of significance $(\alpha)$, so we reject the null hypothesis $(H_0)$ or in other words data does not provide any evidence in favour of null hypothesis $(H_0)$. So $p$-value is significant with both models. When the demographical variables were entered, the $p$ value is greater than .05, which indicates that the predictors with demographical variables are not significant. In conclusion, the model proposed for users of fitness apps is a better predictor of intention to use with the three variables added to the original framework.

**Variables Entered/Removed[a]**

| Model | Variables Entered | Variables Removed | Method |
|---|---|---|---|
| 1 | Huser, PVuser, HMuser, SIFuser, SISuser, EEuser, PEuser, FCuser[b] | . | Enter |

| | | | |
|---|---|---|---|
| 2 | Privuser, HVuser, Truser[b] | . | Enter |

a. Dependent Variable: CUuser

b. All requested variables entered.

Table 5.19 Hierarchical Regression for app users

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | Change Statistics | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | R Square Change | F Change | df1 | df2 | Sig. F Change |
| 1 | .808[a] | 0.653 | 0.616 | 1.723 | 0.653 | 17.650 | 8 | 75 | 0.000 |
| 2 | .833[b] | 0.694 | 0.647 | 1.653 | 0.041 | 3.174 | 3 | 72 | 0.029 |

a. Predictors: (Constant), Huser, PVuser, HMuser, SIFuser, SISuser, EEuser, PEuser, FCuser

b. Predictors: (Constant), Huser, PVuser, HMuser, SIFuser, SISuser, EEuser, PEuser, FCuser, Privuser, HVuser,

Table 5.20 Hierarchical Regression for app users

**Variables Entered/Removed[a]**

| Model | Variables Entered | Variables Removed | Method |
|---|---|---|---|
| 1 | Huser, PVuser, HMuser, SIFuser, SISuser, EEuser, PEuser, FCuser[b] | . | Enter |
| 2 | Privuser, HVuser, Truser[b] | . | Enter |
| 3 | Age, Gender, Education[b] | . | Enter |

a. Dependent Variable: CUuser

b. All requested variables entered.

Table 5.21 Hierarchical Regression for app users

| Model Summary | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | Change Statistics | | | | |
| | | | | | R Square Change | F Change | df1 | df2 | Sig. F Change |
| 1 | .808[a] | 0.653 | 0.616 | 1.723 | 0.653 | 17.650 | 8 | 75 | 0.000 |
| 2 | .833[b] | 0.694 | 0.647 | 1.653 | 0.041 | 3.174 | 3 | 72 | 0.029 |
| 3 | .841[c] | 0.707 | 0.647 | 1.652 | 0.013 | 1.021 | 3 | 69 | 0.389 |
| a. Predictors: (Constant), Huser, PVuser, HMuser, SIFuser, SISuser, EEuser, PEuser, FCuser | | | | | | | | | |
| b. Predictors: (Constant), Huser, PVuser, HMuser, SIFuser, SISuser, EEuser, PEuser, FCuser, Privuser, HVuser, | | | | | | | | | |
| c. Predictors: (Constant), Huser, PVuser, HMuser, SIFuser, SISuser, EEuser, PEuser, FCuser, Privuser, HVuser, | | | | | | | | | |

Table 5.22 Hierarchical Regression for app users

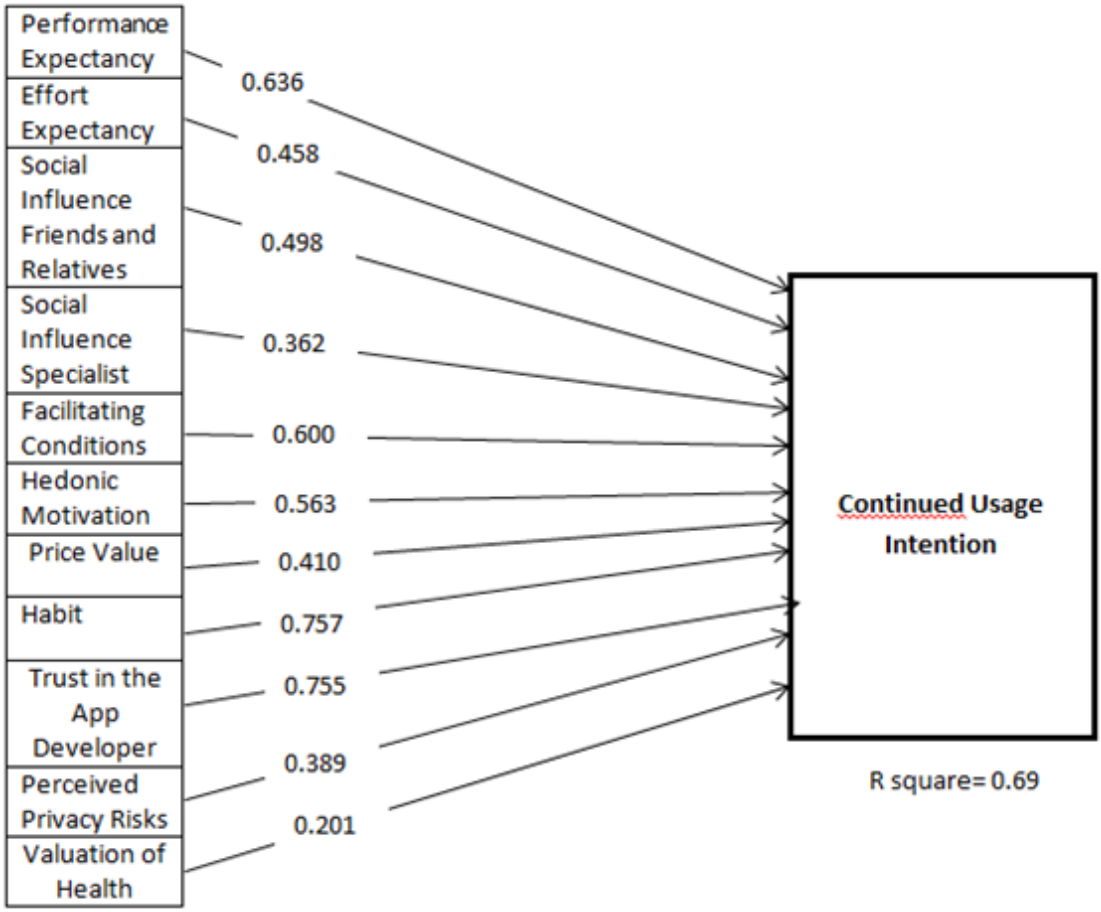



Table 5.23 Factors for app users

### 5.6.2. Hierarchical Regression for Non-users of fitness apps

The process was also carried out for the data from non-users of fitness apps. The UTAUT2 framework's variables were entered and then the other three factors added to the proposed model. The change in the R square (as shown in

the tables below) indicates how much predictive power was added to the model by the addition of further variables. More over $p$-value is significant with both models. Furthermore, when the demographical variables have been entered, the *p* value shows that it is significant, which indicates that the predictors with demographic variables have increased the predictive power to the model. Thus, the model proposed for non-users of fitness apps is a better predictor of intention to use with the three variables that have been added to the original framework.

**Variables Entered/Removed[a]**

| Model | Variables Entered | Variables Removed | Method |
|---|---|---|---|
| 1 | Hap Non User, EE Non User, SIS Non User, Price Value Non User, SIF Non User, HM Non User, PE Non User, FC Non User[b] | . | Enter |

| | | | |
|---|---|---|---|
| 2 | Privacy Non User, Health Val Non User, Trust Non User[b] | . | Enter |
| 3 | Age, Education, Gender[b] | . | Enter |

a. Dependent Variable: Item To user Non User

b. All requested variables entered.

Table 5.24 Hierarchical Regression for app non-users

**Model Summary**

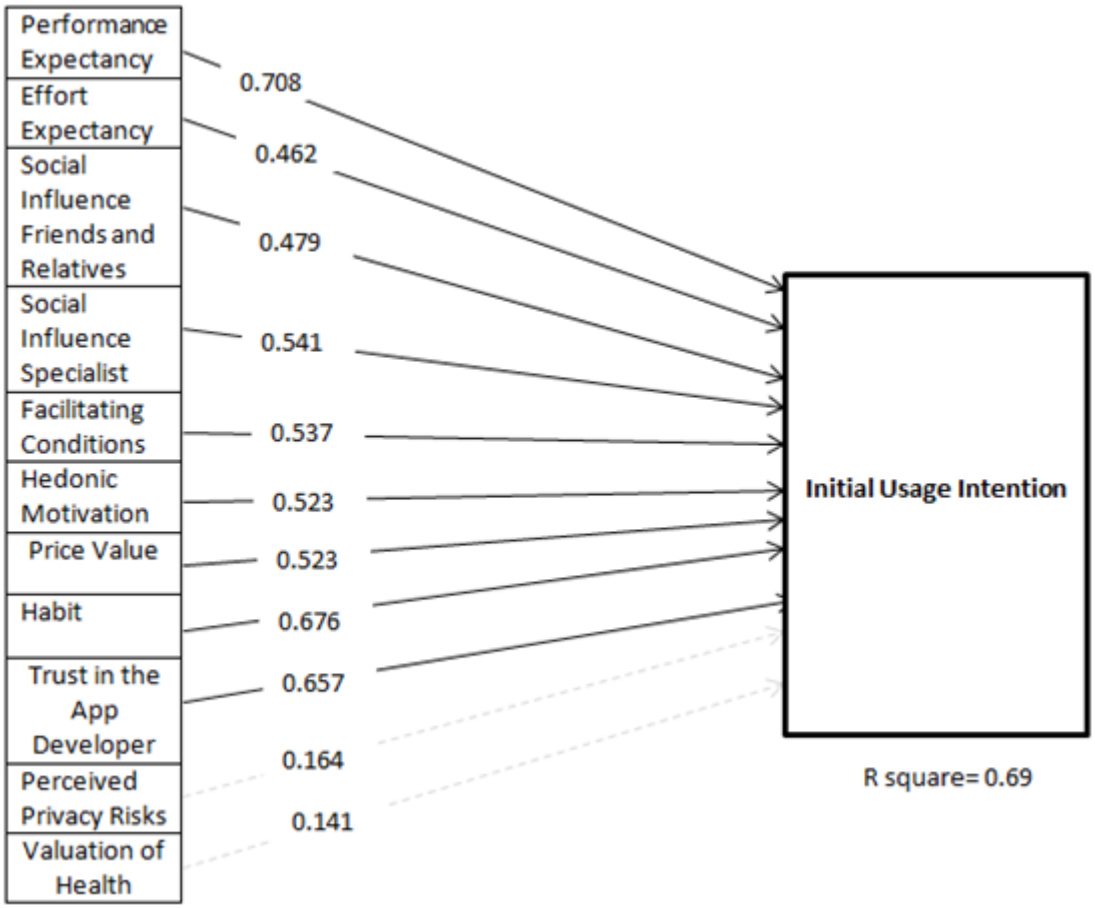
| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | Change Statistics | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | R Square Change | F Change | df1 | df2 | Sig. F Change |
| 1 | .806[a] | 0.650 | 0.616 | 1.708 | 0.650 | 19.236 | 8 | 83 | 0.000 |
| 2 | .830[b] | 0.690 | 0.647 | 1.637 | 0.040 | 3.427 | 3 | 80 | 0.021 |
| 3 | .852[c] | 0.725 | 0.675 | 1.570 | 0.036 | 3.352 | 3 | 77 | 0.023 |

a. Predictors: (Constant), HapNonUser, EENonUser, SISNonUser, PriceValueNonUser, SIFNonUser, HMNonUser,

b. Predictors: (Constant), HapNonUser, EENonUser, SISNonUser, PriceValueNonUser, SIFNonUser, HMNonUser,

c. Predictors: (Constant), HapNonUser, EENonUser, SISNonUser, PriceValueNonUser, SIFNonUser, HMNonUser,

5.25 Hierarchical Regression for app non-users




5.26 Factors for app non-users

## 5.7 Chapter Conclusion

In this chapter, we have described the treatment of data from the questionnaire and the results that have emerged. Three steps of data analysis were carried out, after the Reliability of Measurement described in Chapter Three, which indicated that the items been used are reliable with Cronbach's alpha coefficient greater than 0.7 for all items. First, the Pearson correlation test was used to find out if the correlations between independent variables and dependent variables would be positive or negative. The main finding of this thesis in this regard is that there were significant relationships between independent variables and dependent variables drawn from the original framework UTAUT2 and added variables, i.e. PE: Performance Expectancy, EE: Effort Expectancy, SIF: Social Influence: Friends and relatives, SIS: Social Influence: Healthcare specialists, FC: Facilitating Conditions, H: Hedonic Motivation, PV: Price Value, H= Habit, Trust: Trust, Privacy: Perceived Privacy Risk, VH: Valuation of Health and initial

acceptance and continued usage intention. These are slightly different for each of the two sets of data, i.e. users and non-users of fitness apps.

Secondly, factor analysis was used to confirm that the questions asked for each item are loaded together into one factor. This was confirmed, with nine factors explaining 81% of variance for both users and non-users, **This confirms the accuracy of the UTAUT2 model for which Venkatesh et al claimed that UTAUT2, compared with the original model, produced a substantial improvement in the explained variance of behavioural intention, from 56 per cent to 74 per cent.**

Finally a linear regression analysis was carried out to test the effects of certain predictors independent of the influence of others, as one of the objectives of this study was to determine whether the three newly added variables, trust, privacy and health valuation, show a significant improvement in the proportion of explained variance. We were able to conclude that **the model proposed for users of fitness apps is a better predictor of intention to use with the three variables added to the original framework, and could therefore be of use to future researchers on mHealth app adoption.**

These results are discussed in Chapter Six.

# Chapter Six: Discussion

## 6.1. Introduction

The major aim of this study was to explore the factors that might lead to Saudi young people taking up and continuing the use of mHealth apps to combat overweight and obesity, which are serious problems in the country and the region. Although several aspects of the Saudi Arabian context, particularly the popularity of mobile phones and the gravity of the obesity problem, might encourage take-up of mobile health apps, the literature review revealed several possible obstacles, such as the influence of friends and family, the strength of Saudi cultural customs around food and exercise and attitudes to health.

One of the other reasons for this study was to test the applicability of UTAUT2 to examine the acceptance of mHealth applications that support the health needs of obese people in Saudi Arabia (e.g. fitness apps). The proposed framework for this study was developed based on UTAUT2. Data was analysed by testing the reliability of the variables that have been used and validated by the preliminary research (see Chapter 3). The added variables on the new proposed framework were developed from the literature review and tested as new variables that might contribute to the original framework UTAUT2 in the context of mHealth applications that support the health needs of obese people in Saudi Arabia (e.g. fitness apps).

Most of studies focus on the initial usage intention of mHealth (fitness Apps) yet, not the continued usage intention for fitness apps. However, in this thesis the focus was on both initial usage intention and continued usage intention for fitness apps: the fact that approximately half our respondents already had experience of fitness app gave the opportunity to conduct a quasi-longitudinal study comparing both groups. In other words, if we consider the two populations to be comparable we can infer that the results of app users represent the evolution of attitudes and behaviour of current non-users. In order to explore the factors that affect initial acceptance and continued usage intention UTAUT2 has used and new factors have added to the original framework.

The original research questions for the study (Section 1.4) were as follows:

1. What drives consumers' initial usage intention, in Saudi Arabia, with regard to smartphone fitness apps?
2. What are the barriers to consumers' initial intention to adopt these technologies?
3. Once using the applications, what influences a consumer's decision to continue to use them or not?
4. Does the UTAUT2 model provide an appropriate model or tool for investigating IT adoption in the Saudi context?
5. Is a model of cross-cultural characteristics useful in interpreting consumer attitudes in this context?

In this chapter, we consider how far the data has allowed us to find answers to these questions.

## 6.2 Relations between variables

### 6.2.1 Results for non-users

In this section and section 6.3.2, targeting Research Questions 1 and 2, we review the relations between framework variables, in line with the original hypotheses, which we repeat here for convenience. (Note: for convenience, we distinguish between hypotheses affecting non-users, which will be referred to as H1a, H2a and so on and those affecting users, which will be referred to as H1b, H2b and so on)

> H1: performance expectancy positively affects intention to use and continuation to use fitness apps.
>
> H2: effort expectancy positively affects intention to use and continuation to use fitness apps.
>
> H3a: social influence created by friends and relatives positively affects intention to use and continuation to use fitness apps.
>
> H3b: social influence created by health specialists positively affects intention to use and continuation to use fitness apps.

H4: facilitating conditions positively affect intention to use and continuation to use fitness app.

H5: hedonic motivation positively affects intention to use and continuation to use fitness app.

H6: price value positively affects intention to use and continuation to use fitness app.

H7: habit positively affects intention to use and continuation to use fitness app.

H8: trust positively affects intention to use and continuation to use fitness app.

H9: perceived privacy risks negatively affect intention to use and continuation to use fitness app.

H10: valuation of health positively affects intention to use and continuation to use fitness app.

H11: trust moderates perceived privacy risks.

In this section we report on the results relating to each hypothesis, with an informal version of each conclusion in **bold**. Read together, the bold statements summarise results for each set of respondents, i.e. users and non-users

There is positive correlation between Performance Expectancy and Initial Usage Intention at a very high 0.708. This confirms Hypothesis H1a, i.e. that for current non-users, performance expectancy positively affects intention to use and continuation to use fitness apps. **Saudi non-users of fitness apps appear to be convinced by claims of the efficacy of mHealth apps and wiling to adopt them on that basis.**

There is also a positive correlation between Effort Expectancy and Initial Usage Intention, at 0.462, confirming Hypothesis H2a, effort expectancy positively affects intention to use fitness app. **Saudi respondents assume ease of use in the apps.**

Social influence was separated into two parts, Friends and Relatives' Social Influence and Healthcare Specialists' Social Influence (see Chapter Two). The results demonstrated that there is a positive correlation between Social Influence (in both parts) and Initial Usage Intention. Social Influence is a significant predictor for the intention to using fitness apps in Saudi context, confirming hypotheses H3a a, social influence created by friends and relatives positively affects intention to use (at 0.479) and Hypothesis H3ba, social influence created by health specialists positively affects intention to use fitness apps (0.541). **Non-users expect that formal medical endorsements will be more influential on the eventual take-up of fitness apps than the approval of friends and relatives.** This positive impact of social influence also substantiates Al-Gahtani et al's 2007 findings on ICT acceptance in Saudi Arabia, which they suggest conform to expectations of Hofstede's Cultural Dimension scores for the country:

> In cultures characterized by a high *power distance* dimension, we argued that individuals would be more inclined to show deference to authority and conform to the expectations of others in important or superior roles. Consequently, we expected that higher *power distance* cultures would exhibit a stronger association between *subjective norm* (i.e. Social Influence factors in the current study) and *behavioral intention*. We also argued that the low individualism country score for Saudi Arabia might indicate a strong relationship between *subjective norms* and *behavioral intentions* in the Arab world (Al-Gahtani et al, 2007, p. 689).

There is a positive correlation, of 0.547, between Facilitating Conditions and Initial Usage Intention, confirming Hypothesis H4a. **Saudi respondents do not foresee any technical issues, and already are very likely to own a mobile phone.**

The correlation between hedonic motivation and initial usage intention is positive, at 0.523. In other words, perceived enjoyment is a predictor of the intention to using fitness apps in Saudi context, supporting Hypothesis H5a. **Saudi non-users expect that using an mHealth app will be enjoyable.**

The results show that there is also a positive correlation between price value and initial usage intention, at 0.523. **Fitness apps are perceived as offering**

**good value for money.** This supports Hypothesis 6a, that Price Value positively affects Initial Usage Intention.

There is a positive correlation between Habit and Initial Usage Intention, at a relatively high 0.676. Saudi respondents believe that they will adopt the habit of using fitness apps and that they will be routinised. Hence, the prediction of Habit is a strong predictor to intention in using fitness apps, supporting Hypothesis H7a, habit positively affects intention to use fitness app. **Saudi non-users are confident that they will easily take to the habitual use of mHealth apps.**

There is a strong positive correlation at 0.657 between what we have called Trust and Initial Usage Intention. In other words, the more a consumer trusts the veracity of the promises of the apps provider, the more positive correlation will be with the intention to use fitness apps in the Saudi context. Hence Hypothesis H8a, Trust positively affects intention to use fitness app, is supported. As noted above, it may be that there is some overlap between the content of the questions making up the Trust construct and the construct of Performance Expectancy. This construct could perhaps be refined in future work. **Saudi non-users tend to trust the promises of mHealth app providers.**

There is a positive correlation between privacy concerns and initial usage intention: however, this is very weak at 0.164. This allows us to reject Hypothesis H9a, that perceived privacy risks negatively affect intention to use fitness apps. This is rather surprising given the reluctance to share data that emerged in our focus group (see above, Section 3.3.2.3), where female participants in particular said they would refuse to share health and exercise details, particularly about obesity but that this might change if they were assured of anonymity. It may be that non-users lack a realistic idea of the functionality and services of the fitness apps they might adopt and do not appreciate what data might be gathered. The unequal numbers of female and male participants may also have had an affect here, with male respondents les worried about privacy. Overall, though, **Saudi non-users are reasonably happy to entrust their personal data to mHealth apps**.

Also weakly supported, at 0.141, is Hypothesis 10a, valuation of health positively affects intention to use fitness app. The questions making up this construct ask about the importance of a healthy lifestyle to the participant. A low scoring answer would logically imply a corresponding lack of interest in fitness apps. However, this does not seem to be the case, as raw intention to use is a relatively high 3.495 (out of 5) for non-users (Table 5.9). It may be that participants were young and optimistic about their health, meaning they did not feel a need to worry about healthy living, but also keen on technology, meaning they were keen to adopt mHealth apps. The new construct of health valuation is clearly a complex one, and would repay further study.

### 6.2.2 Results for current users

With respect to Research Question 3, for users of fitness apps, the data shows a relatively strong positive correlation (0.636) between Performance Expectancy and Continued Usage Intention, which we can interpret to mean that the user of fitness apps believes that using fitness apps helps them to lead a healthy lifestyle, making them willing to continue using it. This supports Hypothesis H1b that performance expectancy positively affects intention to continuation to use fitness apps. **Saudi users of mHealth apps expect them to perform well and this makes them likely to continue using them.**

There is weaker but still positive correlation (0.458) between Effort Expectancy and Continued Usage Intention. This is a very similar level to that of non-users, perhaps showing that **users who do start to use the apps are not disillusioned by any lack of usability**. This supports Hypothesis H2b effort expectancy positively affects intention to continue to use fitness apps.

For Social Influence among adopters, the results demonstrated a positive correlation between Social Influence (both types) and Continued Usage Intention. Interestingly, though, where non-users gave slightly more weight to the opinions of the medical profession, actual adopters score friends' and family's influence considerably higher (0.498) than influence from the medical profession (0.362). This may mean that once users engage with an app, their confidence in their judgements about health-related behaviour is raised and they do not feel the need for medical approval. However, they do value the

support of friends and family. These nuances of meaning would be a thread to be explored in any further research. Social Influence is a predictor for the intention to continue using fitness apps in Saudi context, supporting the Hypothesis H3aa, that social influence created by friends and relatives positively affects intention to continue to use fitness app and more weakly Hypothesis H3ba that social influence created by health specialists positively affects intention to continue to use fitness apps. **Social influences are important factors for Saudi mHealth app users**: this could be explored further by public health-oriented research.

There is a relatively strong positive correlation between Facilitating Conditions and Continued Usage Intention for app users at 0.6., supporting Hypothesis H4b, facilitating conditions positively affect intention to continue to use fitness apps. **MHealth app users do not report any problems due to technology access**.

The correlation between Hedonic Motivation and Continued Usage Intention was positive and relatively strong at 0.563. **Those who had used fitness apps and enjoyed using them were likely to continue**. Actual enjoyment was slightly higher than expected enjoyment from the non-user population, with HM construct scores at 0.563 vs 0.523.The results support Hypothesis H5b that hedonic motivation positively affects intention to continue to use fitness apps.

The results show that there is also a positive correlation between Price Value and Continued Usage Intention, though at 0.41 this was a lower value than for non-users at 0.523. **Fitness apps are still perceived as offering good value for money** supporting Hypothesis 6b, that Price Value positively affects Continued Usage Intention.

There is a strong positive correlation between Habit and Continued Usage Intention, at a very high 0.757, compared to non-users' level of 0.676. **Saudi respondents find fitness apps become part of their routine**, making it more likely that they will continue to use them, thus supporting Hypothesis 7b, that Habit positively affects Continued Usage Intention.

There is a strong positive correlation between Trust and Continued Usage Intention, with a very high 0.755. We could interpret this to mean that **their high expectations about the quality of the apps they used had been substantiated**, supporting Hypothesis 8b, that Trust positively affects Continued Usage Intention.

When users of fitness apps were asked about their privacy concerns, there was a positive, but quite low, correlation (0.389) between this factor and continued usage intention. This is a stronger correlation than that for non-users, indicating that users of fitness apps in Saudi context saw more risks in using fitness apps than non-users, possibly resulting from a greater awareness of the app functionality. This rejects the Hypothesis H9b that perceived privacy risks negatively affect intention to continue to use fitness apps. **Once they use an mHealth app, users may become more realistic in their awareness of privacy issues.**

Results showed a weak positive correlation between valuation of health and the intention to continue using fitness apps. This is a stronger correlation than that found for non-users: this may be natural, as users of fitness apps have demonstrated a concern to lead a healthy lifestyle. This supports H10b valuation of health positively affects intention to continue use of fitness apps., i.e. **those concerned with their health (and perhaps those who also feel a personal responsibility for their health) tend to believe they will continue with health apps**, though this is not as strong a link as would intuitively seem logical.

### 6.2.3 Initial Usage and Continued Use: cultural considerations

According to Hofstede, the culture in Saudi is considered to be uncertainty avoiding (Hofstede, n.d.), which may influence the decisions that people will make in a range of contexts. In other words: Saudi people would be less likely than other nationalities to decide to adopt an innovation unless that decision has been made by someone with the power to persuade people to use it. In this study, results showed that there is a significant correlation between Social influence (family and friends) and both Continued and Initial Usage Intention, which demonstrates that family and friends' view of a new technology is vital in

the Saudi society. This relates to the issues explored in the introduction, where social pressure to conform was seen to be particularly strong in Saudi society, as opposed to the more individualistic societies of the West and elsewhere. Hofstede's cultural dimensions consider Saudi Arabia as a collectivist society, which means everyone follows the group, so taking a decision has to fit into the group's thinking, even when a behaviour is actually allowed by law, as in the case of Bursztyn et al's (2018) investigation of the lack of women in the Saudi labour force: they found that Saudi husbands were heavily influenced by their perceptions of the disapproval of other husbands, and that once reassured that many husbands actually agreed with their wives taking up work, were willing to support this themselves.

The influence of healthcare professionals was important before users had direct experience of the innovation, again suggesting the power of those higher in the social hierarchy: Power Distance is high in Saudi Arabia, according to the Cultural Dimensions analysis. A number of recent public health oriented projects have attempted to take advantage of this tendency (Al-Hazzaa, 2018; Alahmed, 2018). Once users had adopted the app, they were less likely to be influenced by medical opinion, perhaps suggesting that they became empowered by the technology. This would be an interesting thread to develop in further work, perhaps in conjunction with a consideration of social media in the country.

## 6.3 Demographic factors: gender and age

### 6.3.1 Gender: Non users

Raw scores from the questionnaire indicate that the male participants had higher mean values for Performance Expectancy, Effort Expectancy, Social influence (friends and family), Facilitating Conditions, Price Value, Habit, Trust and Continued Usage Intention compared with females participants. On the other hand the female participants had higher mean values for Social influence of healthcare professionals, Hedonic Motivation, Privacy and Health valuation. However, the differences are not significant at a level of sig 0.05.

### 6.3.2 Gender: Users

For users of fitness apps, male and female users' scores are very similar, but female participants had higher mean values for all except one factor compared with male participants. The one factor where males scored slightly higher was Social Influence of friends and family, perhaps slightly surprising in a society where women are very constrained by social influence compared to men. However, it is not significant at level of sig 0.05.

### 6.3.3 Age: non-users

the age groups who do not use fitness apps have agreed or strongly agreed for all variables. A comparison of mean values of age groups on initial usage intention showed that the age group of 25 years or less showed the highest mean value with (m= 3.604) followed by the age group of 41-55 with mean value (m=3.551) then age group of 26-40 with mean value (m= 3.446). However, the differences across age groups are not significant at the level of sig 0.05.

### 6.3.4 Age: users

A comparison of mean values of age groups on continuing usage intention showed that the age group of 25 years or less showed the highest mean value with (m= 3.741) followed by the 26-40 age group with mean value (m=3.398) then age group of 41-55 with mean value (m= 3.208). However, again the differences across age groups are not significant at the level of sig 0.05.

The results showed a high level of uniformity across age and gender, indicating that Saudis such as those in the study are generally enthusiastic about mHealth apps, which should be an encouraging result for public health professionals. The general agreement across gender and age boundaries is not surprising given the study demographic, which targeted young people with a university background, a more homogeneous sample than the general population.

## 6.4. The application of the UTAUT and proposed models

The model proposed in this study can explain 81% of the variance in ITU (Intention To Use) and 81% of the variance in CUI (Continued Usage Intention) compared to the UTAUT2 model, which can explain 74% of the variance in 'ITU'

(Intention To Use) and 52% of the variance in ‘CUI’ (Continued Usage Intention. However, the implication of these figures is limited, firstly because the factors examined only apply to mHealth adoption in a Saudi context and secondly, the sample size of this research cannot be compared with the large sample size of UTAUT2. Nevertheless, the proposed factors do account for variance when investigating acceptance of mHealth apps that deal with obesity in Saudi Arabia. The findings of the study offer encouraging evidence in support of the proposed research model.

## 6.5 Chapter Conclusion

The results discussed above could have implications for practitioners, especially application developers, services content providers, mobile services manufacturers and scholars who are keen on studying technology acceptance in non-Western contexts. The results of this research suggest an enriched acceptance model of mHealth applications in Saudi Arabia and the Middle East. In the proposed model, all of the initial UTAUT2 hypotheses are verified: Venkatesh himself has suggested that researchers can test the model in new context and add new factors to the model to be applicable for that context.

# Chapter Seven: Conclusions and Future Work

## 7.1. Introduction

Mobile applications for fitness, to support the health needs of obese people in Saudi Arabia, are still in their infancy. Globally marketed apps, such as MyFitnessPal, are available and used, but there is a demand for apps that are targeted to local language, physical environment, cultural context and social norms (Alnasser, 2016; Mansar, 2014). Yet, to develop such a technology in Saudi context there is a need to study the target audience. Exploring the target context gives a general good understanding about the status of mHealth that support the health needs of people in Saudi Arabia, both those who are already overweight or obese and those who wish to avoid this condition, with its attendant risks to health. Furthermore, it improves the interaction between the health sector on the one hand and individual citizens from the other side. In few years from now, it is more likely that the Ministry of Health in Saudi Arabia will introduce some of fitness apps that support the health needs of obese people, as has been done very successfully in the UK, for example, with its hugely successful Couch to 5K, 10 Active and other apps (https://www.nhs.uk/apps-library). Hence, it is possible that health apps will be prescribed as a medical treatment. However, quite a few obstacles still have to be overcome and studies like these will help in investigating successful user adoption.

This chapter draws conclusions from the results (and the implementation) of the study. It provides a brief discussion of the contribution that this research has added to the body of knowledge on adoption of technologies for health and the way it might be used by policy makers. It presents the various limitations of this research and gives some pointers to potential future academic and policy-oriented work in this and related areas.

## 7.2. Implications for potential application of results

The results that can be applied by policy makers are the findings from the studies of users and non-users on the factors influencing take-up. We have explored the influence of the UTAUAT2 factors and extended model factors on initial adoption and continued usage in addressing the three questions:

1. What drives consumers' initial usage intention, in Saudi Arabia, with regard to smartphone fitness apps?
2. What are the barriers to consumers' initial intention to adopt these technologies?
3. Once using the applications, what influences a consumer's decision to continue to use them or not?

For both sets of respondents, users and non-users, there were no very unforeseen results: the UTAUT approach is now well understood, and it would have been surprising either to have uncovered completely new constructs or to have had existing constructs completely discounted. Each factor plays a role in the decision to adopt and continue to use the innovation. Unusually for a UTAUT-based study, in this study, we were able to look at consumers' attitudes from a point before initial intention use to the point of actual use, which gives a quasi-longitudinal understating of the direct impact of each factor on the acceptance of mobile health applications.

There are, however, differences in the degree to which factors play their role. The questionnaire results have shown Performance Expectancy, Expected Ease of Use and Social Influence of health professionals to be the strongest scoring constructs for non-users. The strongest correlations with intention to use an app are performance expectancy, followed by Habit and Trust. Thus for users to adopt and use mobile fitness apps, they must be persuaded of their efficacy (PE), this efficacy must be perceptible for users, apps must be easily assimilated into the users' routine (H) and they must continue to deliver good quality service (Trust). In terms of applying the results in policy and other areas of practice, is therefore important that app use is normalised and is also championed to non-users by health professionals. Once an app is adopted, professional endorsement becomes less necessary

For users, the highest scoring constructs are Performance Expectancy, Expected Ease of Use and Health Valuation. The strongest correlations with intention to use an app are Habit and Trust. Social influence of friends and family is important in both situations. Again, if public health officials in Saudi Arabia wish to promote and encourage mHealth app usage, they should be

devising policies that take advantage of the social influence factor, e.g. by encouraging support groups on social media. This, rather surprisingly, appears to be even more important for male than female participants.

Saudis such as those in the study are generally enthusiastic about mHealth apps, which should be an encouraging result for public health professionals. Overall, the results confirmed the important roles of performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivation, price value, habit, trust, privacy and health valuation in the consumers' use of mobile applications for health that support the fitness needs of people in Saudi Arabia. These are therefore point to the aspects that a policy effort would need to promote and those it would not need to spend much effort on. For instance, the public seem willing to believe the claims for the efficacy of mHealth apps, do not have any fears over devices and connectivity and consider apps good value for money. However, there are some worries over privacy, at least for users, which could be addressed by policy makers. Social influence from medical experts is seen as potentially powerful, but is not yet a strong force: a policy initiative could address this, with a clinician-led campaign. Perhaps most excitingly, social influence from friends and family is very important for both users and non-users, providing an opportunity for social media and face to face peer support, which could combat any real or perceived social opposition to the exercise, diet change and so on encouraged by app, in the same way that the interventions with husbands in Bursztyn et al's 2018 study on women in the labour force actually led to male guardians supporting women returning to work.

With an increased knowledge of the health needs of obese people in Saudi Arabia, an expected benefit for service providers and government is to understand the challenges/issues in regards to the design and implementation of successful mobile applications for health that support the health needs of obese people. The findings of the study contributed to the planning and up-take of mHealth apps that support the health needs of obesity-prone people of other developing countries with similar socio-economic circumstances.

## 7.3. Methodological Implications

In terms of methodology, the study makes two sorts of contributions, first to the UTAUT2 literature and second to the practice of survey work in a Saudi social research context.

Use extended questionnaire

### 7.3.1 Using UTAUT2

One of the objectives of the study was to determine whether UTAUT2 gives a sound understanding of the factors that affect adoption an acceptance of mHealth applications. We found that each of the original UTAUT2 factors was given almost equal weight by respondents, suggesting that over its many years of refinement, the TAM/UTAUT/UTAUT2 approach is basically sound, explaining 74% of variance in intention to use. Evidence from the focus group and literature review suggested a further three factors Three further factors – trust, health valuation and privacy - were added to the research model, and Social Influence was split into two, and it was shown that these newly configured factors contributed to the explanatory power of model in this context.

The model proposed in this study can explain 81% of the variance in ITU (Intention To Use) and 81% of the variance in CUI (Continued Usage Intention) compared to the UTAUT2 model, which can explain 74% of the variance in 'ITU' (Intention To Use) and 52% of the variance in 'CUI' (Continued Usage Intention). Even since this study was begun, privacy concerns and trust in developers have come strongly to the fore in discussions of new technology, particularly social media, and this is likely to be a continued area of concern to potential users. Even in the case of a user population who are not worried about privacy, as in non-users in our sample, it is surely the responsibility of policy makers and others to educate consumers of the risks they are taking with their personal data. As for the valuation of health factor, this could well be an important feature distinguishing between cultures where health is seen as a personal responsibility and those where responsibility is shifted elsewhere, e.g. the state, family or other agency.

However, the implication of these figures is limited, firstly because the factors examined only apply to mHealth adoption in a Saudi context and secondly, the sample size of this research cannot be compared with the large sample size of UTAUT2. Nevertheless, the proposed factors do account for variance when investigating acceptance of mHealth apps that deal with obesity in Saudi Arabia. The findings of the study offer encouraging evidence in support of the proposed research model.

### 7.3.2 Social research in Saudi Arabia

During this study we have used a number of approaches to derive information from Saudi respondents. This has not always been as straightforward as applying techniques from research methods textbooks, given the specific attributes of Saudi culture. It may therefore be of some use to gather the lessons learned at this point.

The main point is the severe constraints placed by Saudi cultural norms on context between unrelated men and women. A Saudi woman is very unlikely to agree to be interviewed alone by a male, Saudi or western. Moreover, most Saudi women will not agree to be interviewed in a mixed focus group setting or in a female only group with a male facilitator. This is certainly the case if the study is set in Saudi Arabia, but may also be the case in a UK setting.

Where the researcher is male, and working alone, e.g. in the case of a lone PhD researcher, possible approaches include the following:

a) Interview Saudi citizens outside the country as proxies and arrange a mixed gender group, with a male researcher. This was the approach taken in the present study, but it was felt that it led to discomfort and restricted disclosure. In addition, expatriates are not typical of the home population and may give misleading information. It is important to make all participants aware of the circumstances before the group meeting takes place so that they are not embarrassed into remaining in a situation that causes discomfort. Ideally this would be done well in advance.
b) Arrange one to one interviews with Saudi citizens outside the country: if the researcher is male and interviewee female, arrange for a female

researcher to be present. Again, It is important to make all participants aware of the circumstances before the group meeting takes place so that they are not embarrassed into remaining in a situation that causes discomfort. Ideally this would be done well in advance.

c) Arrange a women-only focus group with a male researcher facilitating, accompanied by a female colleague. This might work well, again given prior warning.

d) Arrange a women-only focus group with a female researcher facilitating, with the discussion taped or transcribed. This arrangement would be comfortable, but would have the disadvantage of the researcher receiving the data at second hand. Some female respondents may object to an audio recording, making this even more ungainly as an approach. Video recording would provide richer data, but again might not be agreed to, while a two-way mirror approach, as often used in focus group research, might again raise objections.

In Saudi Arabia itself, the most conservative approaches would need to be used, even if this meant loss of data and use of extra resources (e.g. hiring female interviewers). As is clear, there is no perfect solution, but any researcher in this situation should at least be aware of cultural sensibilities and take an ethically informed approach.

Very surprisingly to Western eyes, this reserve may well extend to virtual communication, even via an anonymous questionnaire. This is confirmed by Al-Subaihi's 2008 study of web-based surveys, where he found that significantly more males responded to an invitation to answer on online questionnaire than females, even when they had equal internet skills, and even when care was taken over gender issues, as follows:

> In Saudi Arabia, where values have strong effects on social life, male-female verbal communication is limited. Thus, and in order to control for research-respondent interaction threat, a female data collector was hired to phone (interview) female subjects only, and a male data collector was hired to phone (interview) male subjects (Al-Subaihi, 20018).

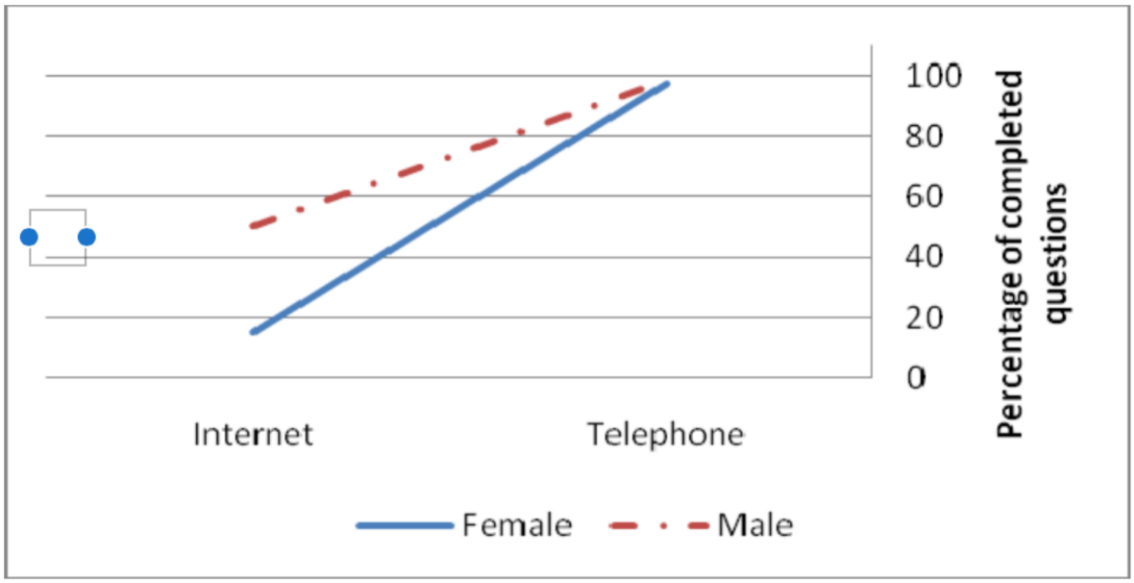



Figure 7.1 Interaction of gender and medium (Al-Subaihi, 2008)

As can be seen from Figure 7.1, Al-Subaihi found, perhaps surprisingly, that Saudi women responded to telephone interviews (with a female researcher) as willingly as male researchers (with a make researcher). In addition, response rates were very high (in the 90% range), which might indicate a solution where resources make it possible.

Some of the problems encountered in arranging access may have limited the effectiveness of the study, and are reported below.

## 7.4. Limitations of the research

This research is subject to a number of limitations.

One major limitation was the nature and size of the sample size. For socio-cultural reasons, as explained above, it was very difficult for the researcher to access female participants, even for an internet-based survey. Therefore we have fewer female than male respondents.

We also took advantage of University networks to distribute the survey: this obviously restricted the sample to those attached to universities, omitting the poorer and less well educated. Similarly, it would have been useful to have had access to a questionnaire population from the non-urban areas: access

precluded this, but again it is a limitation of the study. However, we did achieve a good geographical coverage. It may be that asking users about the area of the country in which they lived might have provided interesting results, as some areas, e.g. the East of the country, are generally regarded more liberal and open to new ideas than others, which may impact on the acceptance of innovations like fitness apps. Similarly, it would have been useful to have had access to a questionnaire population from the non-urban areas: access precluded this, but again it is a limitation of the study. A more geographically nuanced questionnaire might be an interesting extension of the current project.

The research sample maybe not large enough to represents all the fitness apps users, but it was enough to represent the target audience of young Saudis. However, further research with a larger sample and more female participants needed to clarify gender and other differences. Using larger size of sample can give a better understanding of the attitudes of people to the use of mobile applications to prevent and treat obesity and overweight.

Self-selection is a limitation of this study: however, this limitation can be addressed by matching the demographics of the sample with the demographics derived from known population data. However, it would have been valuable to have discovered where the attitudes of the University-educated population are mirrored by those of less well educated young people. This is a limitation of the study, which could be extended in future work.

An enduring problem with surveys on new technology is in ensuring that respondents have a realistic idea of the functionality and interactivity of the device or service that they are being asked about. It may be that non-users lack a realistic idea of the functionality and services of the fitness apps they might adopt. We were made even more aware of this danger in the initial focus group, which asked participants to consider Chabot technology. It was quickly apparent that this was not well understood and that subsequent answers would essentially be meaningless. This meant that in the final questionnaire, we were careful to explain and exemplify the proposed technology before asking any questions about it.

A final limitation that needs to be mentioned, although it is to some extent inherent in any social research, is the possibility that the subjects' responses are not true, and in particular that they suffer from social desirability bias. This is the tendency of research subjects to "to give socially desirable responses instead of choosing responses that are reflective of their true feelings. The bias in responses due to this personality trait becomes a major issue when the scope of the study involves socially sensitive issues such as politics, religion, and environment, or personal issues such as drug use, cheating, and smoking" (Grimm, 2010). High regard for one's health, an aspiration to fitness and confidence in the use of new technologies, though not traditionally thought of as socially sensitive issues, do engage personal feelings of worth, competence and even "coolness", to the extent hat social desirability may govern some responses. This is especially relevant to our questionnaire since it is quite directly personal, asking the respondent what s/he personally feels or does. It might be that, in line with some social desirability researchers such as Nederhof (1985), indirect question forms (do other people feel X) might guard against this tendency. It is worth noting that questionnaires in general are less likely to be subject to this type of reply than a method such as the interview or focus group, where an interviewer is present.

## 7.5. Recommendations for further research

In terms of the model and its explanatory power, future work should perhaps test the possibilities of proposed model factors reduction to make it less complicated.

In terms of understanding attitudes to fitness apps, the immediate need would be for a more qualitative set of studies to explore the meaning of the results such as those on Trust, Privacy and Social Influence, which lend themselves to different interpretations. This could lead to refinements of those constructs.

In addition, younger respondents show a slightly higher level of health valuation than older users. We will see that this is the opposite of the score on this variable for non-users. This could indicate that young people concerned with fitness may already be turning to mHealth apps. These differences are not enough to be significant, but may indicate that the issue of the individual's

thinking about his/her own health is a path worth exploring in more detail in further work. It would be particularly interesting to carry out a cross cultural study of health valuation to see if attitudes differ along national and cultural lines, e.g. between collectivist and individualist societies.

This thesis could be developed by investigating more generally the possible relationship between the proposed model variables and national culture through a more anthropologically oriented study concentrating on cultural attitudes, possibly using Hofstede's Cultural Dimensions, such as Power Distance, Individualism and so on, which have already shown some explanatory power in our discussion.

Over 50 years ago, Rogers proposed a broad set of factors that needed to be taken into account when considering innovation diffusion: the adopters, the communication channels, the social system, the innovation itself and time. Technology acceptance approaches can give us a good account of one of these factors, i.e. the adopters, but a fuller account will need to integrate them all into one picture.

## References


Abanumy, A. & P. Mayhew. (2005). M-government implications for e-government in developing countries: the case of Saudi Arabia. *EURO mGOV* 2005, 1-6.

Abdelhafez, A. M., Al-Mashi, S. S. A. M., & Sa'ad, S. (2013). Prevalence of obesity and some related attributes among Umm Al-Qura university female students in Makkah, Saudi Arabia. *Pakistan Journal of Nutrition*, *12*(3), 275-284.

Abolfotouh, M. A., Ala'a, A. B., Mahfouz, A. A., Al-Assiri, M. H., Al-Juhani, A. F., & Alaskar, A. S. (2015). Using the health belief model to predict breast self examination among Saudi women. *BMC Public Health*, 15(1), 1163.

Abu-Dalbouh, H. M. (2013). A questionnaire approach based on the technology acceptance model for mobile tracking on patient progress applications. *Journal of Computer Science*, *9*(6), 763-770.

Abu-Shanab, E. (2014). Antecedents of trust in e-government services: an empirical test in Jordan. *Transforming Government: People, Process and Policy*, *8*(4), 480-499.

Agarwal, R. & J. Prasad. (1999). Are individual differences germane to the acceptance of new information technologies? *Decision Sciences*, 30(2), 361-391.

Ahmed, M & D. Imad. (2012). *Kingdom of Saudi Arabia Healthcare Overview*, 2009–2012.

Ahluwalia, P., & Varshney, U. (2009). Composite quality of service and decision making perspectives in wireless networks. *Decision Support Systems*, 46(2), 542-551.

Ajzen, I. (1991). The theory of planned behaviour. *Organizational Behavior and Human Decision Process*, Vol. 50, 2, 179-211.

Akbar, F., & Fernandez-Luque, L. (2016, October). What's in the Store? A Review of Arabic Medical and Health Apps in the App Store. In *Healthcare Informatics (ICHI), 2016 IEEE International Conference on* (pp. 413-413). IEEE.

Akter, S., D'Ambra, J., & Ray, P. (2011). Trustworthiness in mHealth information services: an assessment of a hierarchical model with mediating and moderating effects using partial least squares (PLS). *Journal of the Association for Information Science and Technology*, 62(1), 100-116.

Akter, S., Ray, P., & D'Ambra, J. (2013). Continuance of mHealth services at the bottom of the pyramid: the roles of service quality and trust. *Electronic Markets*, 23(1), 29-47.

Al-Ahmed Ali & Ossob Mohamud (2016) *Killing Them Softly: Saudi Ban on Women's Sports is Harming Their Health*. Institute for Gulf Affairs report

Alahmed, Z. and Lobelo, F., 2018. Physical activity promotion in Saudi Arabia: A critical role for clinicians and the health care system. *Journal of epidemiology and global health*, 7, pp.S7-S15.

Alam, A. A. (2008). Obesity among female school children in North West Riyadh in relation to affluent lifestyle. *Saudi medical journal*, *29*(8), 1139-1144.

Alam, M., Khanam, T., & Khan, R. (2010, December). Assessing the scope for use of mobile based solution to improve maternal and child health in Bangladesh: A case study. In *Proceedings of the 4th ACM/IEEE International Conference on Information and Communication Technologies and Development* (p. 3).

Alamri, A., Hassan, M. M., Hossain, M. A., Al-Qurishi, M., Aldukhayyil, Y., & Hossain, M. S. (2014). Evaluating the impact of a cloud-based serious game on obese people. *Computers in Human Behavior*, *30*, 468-475.

Alanzi, T. M., Istepanian, R. S. H., & Philip, N. (2014, February). Usability study of mobile social networking system among Saudi Type 2 diabetes patients (SANAD). In *Biomedical Engineering (MECBME), 2014 Middle East Conference on Biomedical Engineering,* 297-300).

Albabtain, A. F., AlMulhim, D. A., Yunus, F., & Househ, M. S. (2014). The role of mobile health in the developing world: a review of current knowledge and future trends. *Cyber Journals: Multidisciplinary Journals in Science and Technology [JSHI]. Journal of Selected Areas in Health Informatics42*, 10-15.

Albalawi, Y., & Sixsmith, J. (2015). Identifying Twitter influencer profiles for health promotion in Saudi Arabia. *Health promotion international*, *32*(3), 456-463.

Al-Bannay, H., Jarus, T., Jongbloed, L., Yazigi, M., & Dean, E. (2013). Culture as a variable in health research: perspectives and caveats. *Health promotion international 29*(3), 549-557.

Albarrak, A. I., Mohammed, R., Zakaria, N., Alyousef, L. M., Almefgai, N. B., Alqahtani, H. D. & Alsulaiman, A. A. (2016). The impact of obesity related websites on decision making among students in Saudi Arabia. *Saudi Pharmaceutical Journal*, *24*(5), 605-610.

Al-Dowaihi D, Al-Ajlan M, Al-Zahrani N, Al-Quwayfili N, Al-Jwiser N, Kanjo E. (2013) Mbreath: Asthma monitoring system on the go. In: *Proceedings of international conference on computer medical applications (ICCMA)*; 2013. p. 1–4.

Al-Eisa, E. S., & Al-Sobayel, H. I. (2012). Physical activity and health beliefs among Saudi women. *Journal of nutrition and metabolism*, *2012*.

Al-Fahad, F. N. (2009). Students' attitudes and perceptions towards the effectiveness of mobile learning in King Saud University, Saudi Arabia. *The Turkish Online Journal of Educational Technology*, 8(2), 111–119.

Al-Gahtani, S. S., Hubona, G. S., & Wang, J. (2007). Information technology (IT) in Saudi Arabia: Culture and the acceptance and use of IT. *Information & Management*, 44(8), 681-691.

Alghamdi, E., Yunus, F., & Househ, M. S. (2013, June). The impact of mobile phone screen size on user comprehension of health information. In *ICIMTH* (pp. 154-156).

Al-Hazzaa, H.M. and AlMarzooqi, M.A., 2018. Descriptive Analysis of Physical Activity Initiatives for Health promotion in Saudi Arabia. Frontiers in Public Health, 6, p.329.

Al-Hazzaa, H. M., Abahussain, N. A., Al-Sobayel, H. I., Qahwaji, D. M., & Musaiger, A. O. (2011). Physical activity, sedentary behaviors and dietary habits among Saudi adolescents relative to age, gender and region. *International Journal of Behavioral Nutrition and Physical Activity*, *8*(1), 140.

Alhirz Hisham, & A. S. M. Sajeev, (2015) Do cultural dimensions differentiate ERP acceptance? A study in the context of Saudi Arabia, *Information Technology & People*, Vol. 28 Issue: 1, pp.163-194

Al Hosni, Noura, Saqib Ali, and Rafi Ashrafi. "The key success factors to mobile commerce for Arab countries in Middle East." In Proceedings of the 12th International *Conference on Information Integration and Web-based Applications & Services*, pp. 787-790. ACM, 2010.

Ali, H. I., Baynouna, L. M., & Bernsen, R. M. (2010). Barriers and facilitators of weight management: perspectives of Arab women at risk for type 2 diabetes. Health & social care in the community, 18(2), 219-228.

Al-Isa, A. N. (1999). Dietary and socio-economic factors associated with obesity among Kuwaiti college men. *British Journal of Nutrition*, *82*(05), 369-374.

Al-Jaaly, E. (2012). Food Advertising Watched by Adolescent Girls in Saudi Arabia. *World Sustainable Development*.

AlKadi, K., & Roudsari, A. (2013). TeMaD system: telecare for managing diabetes in Saudi Arabia. *Enabling Health Healthc ICT*, 183, 57.

Al-Kandari, Y. Y. (2006). Prevalence of obesity in Kuwait and its relation to sociocultural variables. *Obesity Reviews*, *7*(2), 147-154.

Al Ma'Aitah, R., Haddad, L., & Umlauf, M. G. (1999). Health promotion behaviors of Jordanian women. *Health Care for Women International*, *20*(6), 533-546.

Al-Malki, J. S., Al-Jaser, M. H., & Warsy, A. S. (2003). Overweight and obesity in Saudi females of childbearing age. *International Journal of Obesity*, 27(1), 134.

Almalki, M., FitzGerald, G., & Clark, M. (2011). Health care system in Saudi Arabia: an overview/Aperçu du système de santé en Arabie saoudite. *Eastern Mediterranean health journal*, *17*(10), 784.

Alnasser, A. A., Alkhalifa, A. S., Sathiaseelan, A., & Marais, D. (2015). What overweight women want from a weight loss app: a qualitative study on Arabic women. *JMIR mHealth and uHealth*, *3*(2).

Alnasser, A. A., Amalraj, R. E., Sathiaseelan, A., Al-Khalifa, A. S., & Marais, D. (2016). Do Arabic weight-loss apps adhere to evidence-informed practices?.*Translational behavioral medicine*, *6*(3), 396-402.

Alnasser, A., Sathiaseelan, A., Al-Khalifa, A., & Marais, D. (2016). Development of 'Twazon': An Arabic App for Weight Loss. *JMIR research protocols*, *5*(2).

Al-Nuaim, A. A., Al-Nakeeb, Y., Lyons, M., Al-Hazzaa, H. M., Nevill, A., Collins, P., & Duncan, M. J. (2012). The prevalence of physical activity and sedentary behaviours relative to obesity among adolescents from Al-Ahsa, Saudi Arabia: rural versus urban variations. *Journal of nutrition and metabolism*, *2012*, 1-9.

Alotaibi, M. M. (2015). A Study on the needs for Educating and managing Fasting Diabetes through mobile health in kingdom of Saudi Arabia. *International Journal of Computer Systems*, *2*(04).

Alqarni, S. S. M. (2016). A Review of Prevalence of Obesity in Saudi Arabia. *Journal of Obesity & Eating Disorders*, No page numbers.

Al-Qurishi, M. S., Mostafa, M. A., Alrakhami, M. S., & Alamri, A. M. (2014, July). StarsRace: A mobile collaborative serious game for obesity. In *Multimedia and Expo Workshops (ICMEW), 2014 IEEE International Conference on* (pp. 1-5).

Alqout, O., & Reynolds, F. (2014). Experiences of obesity among Saudi Arabian women contemplating bariatric surgery: an interpretative phenomenological analysis. *Journal of health psychology*, 19(5), 664-677.

Alrajeh, N. A., Lloret, J., & Canovas, A. (2014). A framework for obesity control using a wireless body sensor network. *International Journal of Distributed Sensor Networks*, 10(7), 534760.

Al-Rethaiaa, A. S., Fahmy, A. E. A., & Al-Shwaiyat, N. M. (2010). Obesity and eating habits among college students in Saudi Arabia: a cross sectional study. *Nutrition journal*, 9(1), 39.

Al-Rubeaan, K. A., Youssef, A. M., Subhani, S. N., Ahmad, N. A., Al-Sharqawi, A. H., & Ibrahim, H. M. (2013). A Web-based interactive diabetes registry for health care management and planning in Saudi Arabia. *Journal of medical Internet research*, *15*(9).

Al-Shawi, A., & Al-Wabil, A. (2012).Internet Usage by faculty in Saudi higher education. *International Journal of Computer Science Issues (IJCSI)*, 9(3).

Al-Shehri, S. (2013).An Outlook on Future Mobile Learning in Saudi Arabia. *Proceedings 12th World Conference on Mobile and Contextual Learning* [mLearn 2013), p. 9.

Al-Shorbaji, N. (2008). EHealthin the Eastern Mediterranean Region: a decade of challenges and achievements. *Eastern Mediterranean Health Journal*, 14, 157-173.

Al-Subaihi, A.A., 2008. Comparison of web and telephone survey response rates in Saudi Arabia.

Alsulame, K., Khalifa, M., & Househ, M. (2016). EHealthstatus in Saudi Arabia: A review of current literature. *Health Policy and Technology*, *5*(2), 204-210.

Alturki, R. M., & Gay, V. (2007). A systematic review on what features should be supported by fitness apps and wearables to help users overcome obesity. *Esat Journals.net*

Altuwaijri, M. M. (2008). Electronic-health in Saudi Arabia. Just around the corner? *Saudi Medical Journal*, 29(2), 171-178.

Al-Yousuf M, Akerele TM, Al-Mazrou YY. Organization of the 23. Saudi health system. *Eastern Mediterranean Health Journal*, 2002, 8:4–5.

Alzaid, A. (2012). Diabetes: A tale of two cultures. *British Journal of Diabetes and Vascular Disease.* Volume: 12 issue: 2, 57-59

Ami-Narh, J. T., & Williams, P. A. (2012). A revised UTAUT model to investigate EHealthacceptance of health professionals in Africa. *Journal of Emerging Trends in Computing and Information Sciences*, *3*(10), 1383-1391.

Amin, T. T., Al-Sultan, A. I., & Ali, A. (2008). Overweight and obesity and their relation to dietary habits and socio-demographic characteristics among male primary school children in Al-Hassa, Kingdom of Saudi Arabia. *European journal of nutrition*, 47(6), 310.

Amin, T. T., Al Khoudair, A. S., Al Harbi, M. A., & Al Ali, A. R. (2012). Leisure time physical activity in Saudi Arabia: prevalence, pattern and

determining factors. *Asian Pacific Journal of Cancer Prevention*, *13*(1), 351-360.

Ammenwerth, E., Kaiser, F., Wilhelmy, I., & Hofer, S. (2003). Evaluation of user acceptance of information systems in health care: the value of questionnaires. *Studies in health technology and informatics*, 643-648.

Anckar, B., Carlsson, C., & Walden, P. (2003, June 9-11). Factors affecting consumer adoption decisions and intents in mobile commerce: Empirical insights. In *Proceedings of the 16th Electronic Commerce Conference*, Bled, Sloveni, p. 28.

Andreassen, H. K., Bujnowska-Fedak, M. M., Chronaki, C. E., Dumitru, R. C., Pudule, I., Santana, S. & Wynn, R. (2007). European citizens' use of EHealthservices: a study of seven countries. *BMC Public Health*, 7(1), 53.

Asch, S. E. (1951). Effects of group pressure upon the modification and distortion of judgments. In H.Guetzkow (Ed.), *Groups, leadership and men*. Pittsburg, PA: Carnegie Press, 222-236.

Ashton, J. (1988). Acheson: A missed opportunity for the new public health. *British medical journal (Clinical research ed.),* 296(6617), 231.

Atef Elhamy Kamel, M. (2013). Encouraging walkability in GCC cities: Smart urban solutions. *Smart and Sustainable Built Environment*, *2*(3), 288-310.

Awad, N. F., & Krishnan, M. S. (2006). The personalization privacy paradox: an empirical evaluation of information transparency and the willingness to be profiled online for personalization. *MIS quarterly*, 13-28.

Baabdullah, A., Dwivedi, Y., Williams, M., & Kumar, P. (2015, October). Understanding the Adoption of Mobile Internet in the Saudi Arabian Context: Results from a Descriptive Analysis. In *Conference on e-Business, e-Services and e-Society* (pp. 95-106). Springer, Cham.

Baabdullah, A., Dwivedi, Y. K., & Williams, M. D. (2014, April). Adopting An Extended UTAUT2 To Predict Consumer Adoption Of M-Technologies In Saudi Arabia. In *UKAIS* (p. 5).

Badran, M., & Laher, I. (2011). Obesity in Arabic-speaking countries. *Journal of Obesity*, *2011, 1-10.*.

Baker L, Wagner TH, Singer S & Bundorf MK. (2003).Use of the internet and e-mail for health care information. *JAMA* 2003, 289:2400-6.

Baker, E. W., Al-Gahtani, S. S., & Hubona, G. S. (2007). The effects of gender and age on new technology implementation in a developing country: Testing the theory of planned behavior (TPB). *Information Technology & People*, 20(4), 352–375.

Bakhotmah, B. A. (2011). The puzzle of self-reported weight gain in a month of fasting (Ramadan) among a cohort of Saudi families in Jeddah, Western Saudi Arabia. *Nutrition journal*, *10*(1), 84.

Ball, M. J., & Lillis, J. (2001). E-health: transforming the physician/patient relationship. *International journal of medical informatics*, 61(1), 1–10.

Banville, D., Desrosiers, P., & Genet-Volet, Y. (2000). Translating questionnaires and inventories using a cross-cultural translation technique. *Journal of teaching in Physical Education*, 19(3), 374-387.

Baptista, G. and Oliveira, T., 2015. Understanding mobile banking: The unified theory of acceptance and use of technology combined with cultural moderators. *Computers in Human Behavior*, *50*, pp.418-430.

Bardus, M., J.R Smith, L. Samaha, & C. Abraham, (2016) Mobile Phone and Web 2.0 Technologies for Weight Management: A Systematic Scoping Review. *Journal of Medical Internet Research*. 2015 Nov; 17(11): e259.

Bar-Or, O. (1977). Age-related changes in exercise perception. *Physical Work and Effort*, 255-256.

Baseman JG, Revere D, Painter I, (2013) Public health communications and alert fatigue. *BMC Health Service Research* 2013; 13(1): 1–8.

Benbasat, I. and Barki, H. (2007), "Quo vadis, TAM?" (PDF), Journal of the Association of Information Systems, 8 (4): 211–218

Benjamin, K., & Donnelly, T. T. (2013). Barriers and facilitators influencing the physical activity of Arabic adults: A literature review. *Avicenna*, 8.

BenMessaoud, C. B.; Kharrazi, H.; MacDorman, K. F. (2011). "Facilitators and barriers to adopting robotic-assisted surgery: Contextualizing the Unified Theory of Acceptance and Use of Technology". PLOS ONE. 6 (1)

Beratarrechea, A., Lee, A. G., Willner, J. M., Jahangir, E., Ciapponi, A., & Rubinstein, A. (2014). The impact of mobile health interventions on chronic disease outcomes in developing countries: a systematic review. *Telemedicine and e-Health*, *20*(1), 75-82.

Blake, H. (2008). Innovation in practice: mobile phone technology in patient care. *British Journal of community nursing*, 13(4), 160, 162–5.

Bogart K, Wong SK, Lewis C, (2014) Mobile phone text message reminders of antipsychotic medication: is it time and who should receive them? A cross-sectional trust-wide survey of psychiatric inpatients. *BMC Psychiatry* 2014; 14(1): 15.

Bort-Roig, J., Gilson, N. D., Puig-Ribera, A., Contreras, R. S., & Trost, S. G. (2014). Measuring and influencing physical activity with smartphone technology: a systematic review. *Sports Medicine*, *44*(5), 671-686.

Boudou, P., Sobngwi, E., Mauvais-Jarvis, F., Vexiau, P., & Gautier, J. F. (2003). Absence of exercise-induced variations in adiponectin levels despite decreased abdominal adiposity and improved insulin sensitivity in type 2 diabetic men. *European Journal of Endocrinology*, *149*(5), 421-424.

Breton ER, Fuemmeler BF, Abroms LC. (2011) Weight loss-there is an app for that! But does it adhere to evidence-informed practices? *Transl Behavior in Med.* 2011 Dec; 1(4):523-9.

Brown, S. A. & Venkatesh, V. (2005). Model of adoption of technology in the household: A baseline model test and extension incorporating household life cycle. *MIS Quarterly*, 29(4), 399-426.

Bruner, G. C., & Kumar, A. (2005). Explaining consumer acceptance of handheld Internet devices. *Journal of business research*, 58(5), 553-558.

Buhalis, D (2011), Technological evolution and impacts on strategic management and marketing. In L. Moutinho (ed), *Strategic management in tourism*, 2nd ed, CAB International, Wallingford, England.

Bursztyn L, González AL, Yanagizawa-Drott D. Misperceived social norms: Female labor force participation in Saudi Arabia. *National Bureau of Economic Research*; 2018 Jun 21.

Butler, Ray G.. (2014). *Exploratory vs Confirmatory Research*. https:// www.researchgate.net/publication/267058525_Exploratory_vs_Confirmatory_Research

Canbulat N, Uzun Ö. Health beliefs and breast cancer screening behaviors among female health workers in Turkey. *European Journal Oncology Nursing.* 2008; 12(2):148–56.

Carter, A., Liddle, J., Hall, W., & Chenery, H. (2015). Mobile phones in research and treatment: Ethical guidelines and future directions. *JMIR mHealth and uHealth*, 3(4).

Centers for Disease Control and Prevention (CDC. (2011). Ten great public health achievements--United States, 2001-2010. *MMWR. Morbidity and mortality weekly report*, *60*(19), 619.

Chamieh, M. C., Moore, H. J., Summerbell, C., Tamim, H., Sibai, A. M., & Hwalla, N. (2015). Diet, physical activity and socio-economic disparities of obesity in Lebanese adults: findings from a national study. *BMC public health*, *15*(1), 279.

Chan, C. B., & Ryan, D. A. (2009). Assessing the effects of weather conditions on physical activity participation using objective measures. *International journal of environmental research and public health*, *6*(10), 2639-2654.

Chen, L. (2008). A model of consumer acceptance of mobile payment. *International Journal of Mobile Communications*, 6(1), 32–52. doi:10.1504/ IJMC.2008.015997

Cheong, J. H., & Park, M. C. (2005). Mobile internet acceptance in Korea. *Internet Research*, 15(2), 125–140. doi:10.1108/10662240510590324

Chilisa, B. and Kawulich, B., 2012. Selecting a research approach: paradigm, methodology, and methods. C Wagner, B Kawulich, & M Garner, *Doing social research: A global context,* pp.51-61.

Choe, E. K., Lee, N. B., Lee, B., Pratt, W., & Kientz, J. A. (2014, April). Understanding quantified-selfers' practices in collecting and exploring personal data. In *Proceedings of the 32nd annual ACM conference on Human factors in computing systems* (pp. 1143-1152).

Chuttur, M. Y. (2009). Overview of the technology acceptance model: Origins, developments and future directions. *Working Papers on Information Systems*, 9(37), 9-37.

CIA (2017) *World Fact Book*. Accessible at: https://www.cia.gov/library/publications/the-world-factbook/geos/sa.html

Conroy, D. E., Yang, C. H., & Maher, J. P. (2014). Behavior change techniques in top-ranked mobile apps for physical activity. *American journal of preventive medicine*, *46*(6), 649-652.

Consumer Health Informatics Resource Center (2017) Technology Acceptance Model (Perceived Usefulness and Perceived Ease of Use). Accessible at https://chirr.nlm.nih.gov/tam.php

Coughlin, S. S., Whitehead, M., Sheats, J. Q., Mastromonico, J., Hardy, D., & Smith, S. A. (2015). Smartphone applications for promoting healthy diet and nutrition: a literature review. *Jacobs journal of food and nutrition*, *2*(3), 021.

Coughlin, S. S., Whitehead, M., Sheats, J. Q., Mastromonico, J., & Smith, S. (2016). A review of smartphone applications for promoting physical activity. *Jacobs journal of community medicine*, *2*(1).

Creswell, J & Clark, PV 2010, *Designing and conducting mixed methods research*, 2nd edn, Sage, Thousand Oaks, CA.

Dahlberg, T., Mallat, N., & Öörni, A. (2003). Trust enhanced technology acceptance modelconsumer acceptance of mobile payment solutions: Tentative evidence. *Stockholm Mobility Roundtable*, 22, 23.

Darmon, N., & Drewnowski, A. (2008). Does social class predict diet quality? *The American Journal of Clinical Nutrition*, *87*(5), 1107–17.

Davis, Fred D, (1985). *A technology acceptance model for empirically testing new end-user information system: theory and results*. PhD thesis, Massachusetts Institute of Technology, Sloan School of Management, 1985.

Davis .Fred D. (1989).Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 13(3):319–340.

Davis .Fred D, Richard P. Bagozzi, and Paul R. Warshaw, (1989). User acceptance of computer technology: a comparison of two theoretical models. *Management Science*, 35(8):982–1003.

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1992). Extrinsic and intrinsic motivation to use computers in the workplace. *Journal of Applied Social Psychology*, 22(14), 1111-1132.

DeNicola, E., Aburizaiza, O. S., Siddique, A., Khwaja, H., & Carpenter, D. O. (2015). Obesity and public health in the Kingdom of Saudi Arabia. *Reviews on environmental health*, *30*(3), 191-205.

Ding, L., Velicer, W. F., & Harlow, L. L. (1995). Effects of estimation methods, number of indicators per factor, and improper solutions on structural equation modeling fit indices. *Structural Equation Modeling: A Multidisciplinary Journal*, *2*(2), 119-143.

Dobbins, C., & Rawassizadeh, R. (2015, October). Clustering of physical activities for quantified self and mHealth applications. In *Computer and Information Technology; Ubiquitous Computing and Communications; Dependable, Autonomic and Secure Computing; Pervasive Intelligence and Computing (CIT/IUCC/DASC/PICOM), 2015 IEEE International Conference on* (pp. 1423-1428).

Dodds, W. B., Monroe, K. B., & Grewal, D. (1991). Effects of Price, Brand, and Store Information on Buyers, *Journal of Marketing Research* (28:3), pp. 307-319.

Donnelly, T. T., Al Suwaidi, J., Al Bulushi, A., Al Enazi, N., Yassin, K., Rehman, A. M., & Idris, Z. (2011). The influence of cultural and social factors on healthy lifestyle of Arabic women. Avicenna, (2011), 3.

Drennan, J., 2003. Cognitive interviewing: verbal data in the design and pretesting of questionnaires. *Journal of advanced nursing*, 42(1), pp.57-63.

Drewnowski A & Darmon N. (2005). The economics of obesity: dietary energy density and energy cost. *American Journal of Clniical Nutrition,* 82 (suppl): 265S–73S

Easterby-Smith, M., Thorpe, R. and Jackson, P.R., 2012. *Management research*. Sage.

Ellsworth, J. B. (2000). *Surviving changes: A survey of Educational change models*. Syracuse, NY: ERIC Clearinghouse

El-Mahalli, A. A., El-Khafif, S. H., & Al-Qahtani, M. F. (2012). Successes and challenges in the implementation and application of telemedicine in the eastern province of Saudi Arabia. *Perspectives in health information management/AHIMA, American Health Information Management* Association, 9 (Fall).

Erumban, A.A. and De Jong, S.B., 2006. Cross-country differences in ICT adoption: A consequence of Culture?. *Journal of world business*, 41(4), pp.302-314.

El-Wajeeh, M., Galal-Edeen, G., & Mokhtar, H. (2014). Technology acceptance model for mobile health systems. *IOSR Journal of Mobile Computing and Acceptance*, 1(1), 21-33.

Eum, I. (2008). A Study on Current Culinary Culture and Religious Identity in the Gulf Region* Focused on the Ashura Practice among the Shia Muslims of Bahrain and Kuwait. *International Area Studies Review*, *11*(2), 55-73.

Eysenbach , G. Kohler, C. (2003). What is the prevalence of health-related searches on the World Wide Web? Qualitative and quantitative analysis of search engine queries on the internet. *AMIA Annual Symposium Proceedings* 2003, 225-9.

Eysenbach G. (2001) What is e-health? *Journal of Medical Internet Res*;3(2):E20. http://www.jmir.org/2001/2/e20/

Fan, D., Gong, J., & Lach, J. (2016). Eating gestures detection by tracking finger motion. In *Wireless Health* (pp. 1-6).

Fishbein, M. (1967). *Readings in attitude theory and measurement*. New York, NY: Wiley.

Foerster SB, Hudes M. California Dietary Practices Survey: Focus on Fruits and Vegetables, Trends among Adults, 1989-1993, *Topline Report*. Sacramento, CA: California Department of Health Services and Public Health Foundation; 1994.

Fogg, B. J., Cuellar, G., & Danielson, D. (2009). Motivating, influencing, and persuading users: An introduction to captology. *Human Computer Interaction Fundamentals*, 109-122.

Fogg, B. J. (2009, April). A behavior model for persuasive design. *In Proceedings of the 4th international Conference on Persuasive Technology* (p. 40). ACM.

Free C, Phillips G, Felix L, Galli L, Patel V, Edwards P, (2010). The effectiveness of MHealth technologies for improving health and health

services: a systematic review protocol. *BMC Research Notes*: 3:250–259.

Fritz, T., Huang, E. M., Murphy, G. C., & Zimmermann, T. (2014, April). Persuasive technology in the real world: a study of long-term use of activity sensing devices for fitness. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 487-496). ACM.

Frost & Sullivan (2015) https://medtechengine.com/article/EHealth-western-europe/

Gain, F. P. Gender inequality in Saudi Arabia. Available via *Academic.edu*

Gallagher, E. B., & Searle, C. M. (1985). Health services and the political culture of Saudi Arabia. *Social Science & Medicine*, *21*(3), 251-262.

García-Sánchez, P., González, J., Mora, A. M., & Prieto, A. (2013). Deploying intelligent EHealthservices in a mobile gateway. *Expert Systems with Applications*, 40(4), 1231-1239.

Garmendia, M. L., Alonso, F. T., Kain, J., Uauy, R., & C. Corvalan. (2013).Alarming weight gain in women of a post-transitional country. *Public health nutrition*, 1-7.

Ghoshal, DS, Bartlett, C. (1988). Creation, Adoption and Diffusion of Innovations by Subsidiaries of Multinational Corporations. *The Journal of International Business Studies*, 19(3): 72.

Glanz, K., Rimer, B.K. & Lewis, F.M. (2002). *Health Behavior and Health Education. Theory, Research and Practice.* San Fransisco: Wiley & Sons.

Goode, A. P., Hall, K. S., Batch, B. C., Huffman, K. M., Hastings, S. N., Allen, K. D., ... & Williams, J. W. (2016). The Impact of Interventions that Integrate Accelerometers on Physical Activity and Weight Loss: A Systematic Review. *Annals of Behavioral Medicine*, 1-15.

Grimm, P., 2010. Social desirability bias. *Wiley international encyclopedia of marketing.*

Guo, X., Zhang, X., & Sun, Y. (2016). The privacy–personalization paradox in mHealth services acceptance of different age groups. *Electronic Commerce Research and Applications*, *16*, 55-65.

Haug S, Schaub MP, Venzin V. (2013) Moderators of outcome in a text messaging (SMS)-based smoking cessation intervention for young people. *Psychiatry Praxis* 2013; 40(6): 339–346

Heerink, M., Kröse, B., Wielinga, B., & Evers, V. (2008, March). Enjoyment intention to use and actual use of a conversational robot by elderly

people. In *Proceedings of the 3rd ACM/IEEE international conference on Human robot interaction* (pp. 113-120). ACM.

Helman, D. A., Addeo, E. J., Santoso, N. I., Walters, D. W., & Helman, G. T. (2015). Delivering EHealthcare: Opportunities and Challenges. In *TeleHealth and Mobile Health* (pp. 331-362). CRC Press.

Heron KE, Smyth JM, (2010). Ecological momentary interventions: incorporating mobile technology into psychosocial and health behaviour treatments. *British Journal of Health Psychol*.pp.15:1–39.

Hesse BW, Nelson DE, Kreps GL. (2005).Trust and Sources of Health Information: The Impact of the Internet and Its Implications for Health Care Providers: *Findings from the First Health Information National Trends Survey*, 2618-2624.

Hofstede, G. (2003). *Culture's consequences: Comparing values, behaviors, institutions and organizations across nations*. Sage.

Hofstede, G. (2017) https://geert-hofstede.com/national-culture.html

Holden, R. J., & Karsh, B. T. (2010). The technology acceptance model: its past and its future in health care. *Journal of biomedical informatics*, *43*(1), 159-172.

Househ M. (2012) Islamic e-Health:definitions, applications and challenges. *Studies in Health Technology Informatics* 2012;183:281–5.

Househ, M. (2016). The role of short messaging service in supporting the delivery of healthcare: An umbrella systematic review. *Health informatics journal,* 22(2), 140-150.

Hsu, M.H., Tien, M. H. H. S. W., & Chang, H. C. L. C. M. Understanding the roles of cultural differences and socio-economic status in social media continuance intention. *Information Technology & People*, 28(1), 224-241.

Hu, P. J., Chau, P. Y. K., Liu Sheng, O. R., & Kar Yan, T. (1999). Examining the Technology Acceptance Model using physician acceptance of telemedicine technology. *Journal of Management Information Systems, 16*(2), 91-112.

Hubbard, B. (2015) Young Saudis, Bound by Conservative Strictures, Find Freedom on Their Phones. *New York Times*. Accessible at https://www.nytimes.com/2015/05/23/world/middleeast/saudi-arabia-youths-cellphone-apps-freedom.html

Huddy, C., Herbert, J., Hyner, G., & Johnson, R.(1995).Facilitating changes in exercise behavior. *Psychological Reports*, 76(3), 867-875

Hurling, Robert, Michael Catt, Marco De Boni, Bruce William Fairley, Tina Hurst, Peter Murray, Alannah Richardson, and Jaspreet Singh Sodhi. "Using internet and mobile phone technology to deliver an automated physical

activity program: randomized controlled trial." *Journal of medical Internet research* 9, no. 2 (2007).

Jones, M.L., 2007. Hofstede-culturally questionable? Available at: https://ro.uow.edu.au/commpapers/370/

Kahan, D. (2003). Islam and physical activity: Implications for American sport and physical educators. *Journal of Physical Education, Recreation & Dance*, *74*(3), 48-54.

Kahn, James G., Joshua S. Yang, and James S. Kahn. "'Mobile health needs and opportunities in developing countries." *Health Affairs* 29, no. 2 (2010): 252-258.

Kaliyadan F, Amin TT, Kuruvilla J, Ali WHAB. Mobile teledermatology–patient satisfaction, diagnostic and management concordance, and factors affecting patient refusal to participate in Saudi Arabia*. Journal of Telemedicine Telecare* 2013;19(6):315–9.

Kaplan, W. A. (2006). Can the ubiquitous power of mobile phones be used to improve health outcomes in developing countries. *Global Health*, *2*(9), 399-404.

Kapoor, Kawaljeet Kaur, Michael D. Williams, Yogesh K. Dwivedi, and Banita Lal. "An analysis of existing publications to explore the use of the diffusion of innovations theory and innovation attributes." In Information and Communication Technologies (WICT), 2011 World Congress on, pp. 229-234. IEEE, 2011.

Katula, Jeffrey A., Mara Z. Vitolins, Erica L. Rosenberger, Caroline S. Blackwell, Timothy M. Morgan, Michael S. Lawlor, and David C. Goff. "One-year results of a community-based translation of the diabetes prevention program." *Diabetes care* 34, no. 7 (2011): 1451-1457.

Khalaf, A., Ekblom, Ö., Kowalski, J., Berggren, V., Westergren, A., & Al-Hazzaa, H. (2013). Female university students' physical activity levels and associated factors—a cross-sectional study in southwestern Saudi Arabia. *International journal of environmental research and public health*, *10*(8), 3502-3517.

Khalil, A., & Glal, S. (2009, December). StepUp: A step counter mobile application to promote healthy lifestyle. In *Current Trends in Information Technology (CTIT), 2009 International Conference on the* (pp. 1-5). IEEE.

Kim, Y. H., & Kim, S. H. (2016). The association between body mass index and duration spent on electronic devices in children and adolescents in Western Saudi Arabia. *Saudi medical journal*, *37*(8), 915.

Kim, J., & Park, H. A. (2012). Development of a health information technology acceptance model using consumers' health behavior intention. *Journal of medical Internet research*, *14*(5), e133.

Kinninmont, J. (2015). *Future Trends in the Gulf*. Chatham House Report: The Royal Institute of International Affairs.

Klautzer L, Becker J, Mattke S. The curse of wealth - Middle Eastern countries need to address the rapidly rising burden of diabetes. *International Journal of Health Policy Management.* 2014: 2:109–114.

Koch, S. (2012, August). Improving quality of life through EHealth-the patient perspective. In *MIE* (pp. 25-29).

Kreps, G. L., & Neuhauser, L. (2010). New directions in EHealth communication: opportunities and challenges. *Patient education and counseling*, 78(3), 329-336.

Kuhn, T.S., 2012. *The structure of scientific revolutions*. University of Chicago Press.

Kumar, S., Nilsen, W. J., Abernethy, A., Atienza, A., Patrick, K., Pavel, M., &Swendeman, D. (2013). Mobile health technology evaluation: the mHealth evidence workshop. *American journal of preventive medicine*, 45(2), 228-236.

Kurdi, H. A., Alkhowaiter, A., Al-Muaibed, A., Alotaibi, B., Alhaweal, R., & Alotaibi, T. (2012, November). myPDA: a mobile healthcare application for personal diet assisting. In *Advanced Computer Science Applications and Technologies (ACSAT), 2012 International Conference on* (pp. 491-496). IEEE.

Laakko, T., Leppanen, J., Lahteenmaki, J., & Nummiaho, A. (2008, January). Multipurpose mobile platform for telemedicine applications. In *Pervasive Computing Technologies for Healthcare, 2008. PervasivEHealth 2008. Second International Conference on* (pp. 245-248). IEEE.

Lähdesmäki, A. (2015). Mobile applications for chronic disease self-management: building a bridge for behavior change. PhD thesis University of Applied Sciences, Otaniemi

Lallmahomed, M. Z., Rahim, N. Z. A., Ibrahim, R., & Rahman, A. A. (2013). Predicting different conceptualizations of system use: Acceptance in hedonic volitional context (Facebook). *Computers in Human Behavior,* 29(6), 2776-2787.

Lee, S.G., Trimi, S. and Kim, C., 2013. The impact of cultural differences on technology adoption. Journal of World Business, 48(1), pp.20-29.

Legris, P., Ingham, J., & Collerette, P. (2003).Why do people use information technology? A critical review of the technology acceptance model. *Information Management,* 40(3), 191-204.

Lewis, Z. H., Lyons, E. J., Jarvis, J. M., & Baillargeon, J. (2015). Using an electronic activity monitor system as an intervention modality: A systematic review. *BMC Public Health*, *15*(1), 585.

Li, Junhua, Amir Talaei-Khoei, Holly Seale, Pradeep Ray, and C. Raina MacIntyre. "Health care provider adoption of EHealth: systematic literature review." Interactive Journal of Medical Research 2, no. 1 (2013).

Lim, S., Xue, L., Yen, C. C., Chang, L., Chan, H. C., Tai, B. C. & Choolani, M. (2011). A study on Singaporean women's acceptance of using mobile phones to seek health information. *International journal of medical informatics*, *80*(12), e189-e202.

Lobelo, F., Kelli, H. M., Tejedor, S. C., Pratt, M., McConnell, M. V., Martin, S. S., & Welk, G. J. (2016). The wild wild west: A framework to integrate mHealth software applications and wearables to support physical activity assessment, counseling and interventions for cardiovascular disease risk reduction. *Progress in cardiovascular diseases*, *58*(6), 584-594.

Lunceford, Brett (2009). "Reconsidering Technology Adoption and Resistance: Observations of a Semi-Luddite"*. Explorations in Media Ecology.* 8 (1): 29*–47.*

Lyzwinski, L. N. (2014). A systematic review and meta-analysis of mobile devices and weight loss with an intervention content analysis. *Journal of personalized medicine*, *4*(3), 311-385.

Lyzwinski, L. N., Caffery, L. J., Bambling, M., & Edirippulige, S. (2017). Consumer perspectives on mHealth for weight loss: a review of qualitative studies. *Journal of Telemedicine and Telecare*, 1357633X17692722.

Macedo, I. M. (2017). Predicting the acceptance and use of information and communication technology by older adults: An empirical examination of the revised UTAUT2. *Computers in Human Behavior, pp. 935 – 948.*.

Malhotra, N. K., Birks, D. F., Palmer, A., & Koenig-Lewis, N. (2003). Market research: an applied approach. *Journal of marketing management*, 27, 1208-1213.

Mansar, S. L., Jariwala, S., Behih, N., Shahzad, M., & Anggraini, A. (2014). Adapting a database of text messages to a mobile-based weight loss program: the case of the Middle East. *International journal of telemedicine and applications*, *2014*, 1.

Martínez-Pérez, B., De La Torre-Díez, I., & López-Coronado, M. (2013). Mobile health applications for the most prevalent conditions by the World Health Organization: review and analysis. *Journal of medical Internet research*, 15(6), e120.

Mateo, G. F., Granado-Font, E., Ferré-Grau, C., & Montaña-Carreras, X. (2015). Mobile phone apps to promote weight loss and increase physical activity: a systematic review and meta-analysis. *Journal of medical Internet research*, *17*(11), e253.

Maziak, Wasim. "Health in the middle East." (2006): 815-816.

Mechael, P. N. (2009). The case for mHealth in developing countries.*Innovations*, *4*(1), 103-118.

Mehio-Sibai, A., Kanaan, N., Chaaya, M., Rahal, B., Abdullah, A., & Sibai, T. (2003). Ethnic differences in weight loss behavior among secondary school students in Beirut: the role of weight perception. *Sozial-und Präventivmedizin/Social and Preventive Medicine*, *48*(4), 234-241.

Mobile Health Market Report 2013-2017: The Commercialization of mHealth Applications. Volume 3. Berlin, Germany: research2guidance; 2013. Mar 04.

Mohamed, A. H. H., Tawfik, H., Al-Jumeily, D., & Norton, L. (2011, December). MoHTAM: A technology acceptance model for mobile health applications. In *Developments in E-systems Engineering (DeSE),* 2011 (pp. 13-18). IEEE.

Morgan, D. L. (1998). Practical strategies for combining qualitative and quantitative methods: Applications to health research. *Qualitative health research*, 8(3), 362-376.

Murphy,C. (2011). Saudi Arabia's Youth and the Kingdom's Future. Middle east program occasional paper series. 2 (2), p.3.

Musaiger, A. O. (1987). The state of food and nutrition in the Arabian Gulf countries. In *Nutrition in the Gulf Countries. Malnutrition and Minerals* (pp. 105-173). Karger Publishers.

Musaiger, A. O. (1993). Socio-cultural and economic factors affecting food consumption patterns in the Arab countries. *Journal of the Royal Society of Health*, *113*(2), 68-74.

Musaiger, A. O., Shahbeek, N. E., & Al-Mannai, M. (2004). The role of social factors and weight status in ideal body-shape preferences as perceived by Arab women. *Journal of Biosocial Science*, *36*(06), 699-707.

Musaiger, A. O., & Al-Mannai, M. (2014). Association between exposure to media and body weight concern among female university students in five Arab countries: a preliminary cross-cultural study. *Journal of biosocial science*, *46*(02), 240-247.

Nafea, I., Bhairy, M. N., & Zeidan, Z. A. (2014, November). Health tracking framework for Hajj pilgrims using electronic health records for Hajj. In *Bioinformatics and Biomedicine (BIBM), 2014 IEEE International* Conference on (pp. 605-607). IEEE.

Nagle S., L. Schmidt. (2012) Computer acceptance of older adults *Work*, 41 (2012), pp. 3541-3548.

Nederhof, A.J., 1985. Methods of coping with social desirability bias: A review. European journal of social psychology, 15(3), pp.263-280.

Neufeld, D. J., Dong, L., and Higgins, C. 2007. “Charismatic Leadership and User Acceptance of Information Technology,” *European Journal of Information Systems* (16:4), pp. 494-510.

Neuman, W (2005), Social research methods: quantitative and qualitative approaches, 6th edn, Pearson, Harlow, England.

Newzoo (2017) Global Mobile Market Report, April 2017, https://newzoo.com/insights/rankings/top-50-countries-by-smartphone-penetration-and-users/

Ng, S. W., Zaghloul, S., Ali, H. I., Harrison, G. & Popkin, B. M. (2011). The prevalence and trends of overweight, obesity and nutrition-related non-communicable diseases in the Arabian Gulf States. *Obesity Reviews*, *12*(1), 1-13.

Ngo, J., Engelen, A., Molag, M., Roesle, J., García-Segovia, P. & Serra-Majem, L. (2009). A review of the use of information and communication technologies for dietary assessment. *British Journal of Nutrition*, *101*(S2), S102-S112.

Nielsen, J. (1995). 10 usability heuristics for user interface design. *Fremont: Nielsen Norman Group.*

Niles, Robert, 2006. *"Robert Niles' Journalism Help: Statistics Every Writer Should Know*," RobertNiles.com.

Nuffield Council on Bioethics (2007) *Report on Bioethics and Public Health*. Downloadable at https://nuffieldbioethics.org/project/public-health

Obesity Research Center (2013). Obesity in Saudi Arabia. http://www.obesitycenter.edu.sa/Patients---Public/Obesity-in-Saudi-Arabia.aspx

Oh, J., & Yoon, S. (2014). Predicting the use of online information services based on a modified UTAUT model. *Behaviour & Information Technology*, 33(7).

Or, C. K. L., Karsh, B.-T., Severtson, D. J., Burke, L. J., Brown, R. L., & Brennan, P. F. (2011).Factors affecting home care patients' acceptance of a web-based interactive self-management technology. *Journal of the American Medical Informatics Association, 18*(1), 51-59.

oryxsa.com. (2017) Available at https://oryxsa.com/2013/10/14/how-educated-is-the-population-in-saudi-arabia/

Özbilen, Pınar. "The Impact of Natural Culture on New Technology Adoption by Firms: A Country Level Analysis." *International Journal of Innovation, Management and Technology* 8, no. 4 (2017).

Pavlou PA. Consumer Acceptance of Electronic Commerce: Integrating Trust and Risk with the Technology Acceptance Model. *International Journal of Electronic Commerce*. 2003: 7(3):101–34.

Payne, H. E., Lister, C., West, J. H., & Bernhardt, J. M. (2015). Behavioral functionality of mobile apps in health interventions: a systematic review of the literature. *JMIR mHealth and uHealth*, *3*(1),.

Pellegrini, C. A., Pfammatter, A. F., Conroy, D. E., & Spring, B. (2015). Smartphone applications to support weight loss: current perspectives. *Advanced health care technologies*, *1*, 13-22.

Peng, W., Kanthawala, S., Yuan, S. & Hussain, S. A. (2016). A qualitative study of user perceptions of mobile health apps. *BMC Public Health*, *16*(1), 1158.

Plachkinova, M., Andrés, S., & Chatterjee, S. (2015, January). A Taxonomy of mHealth Apps--Security and Privacy Concerns. In *System Sciences (HICSS), 2015 48th Hawaii International Conference on* (pp. 3187-3196). IEEE.

Porter, D. (1999). Health, civilization, and the state: a history of public health from ancient to modern times. Psychology Press, 1999.

Probst, Y., Nguyen, D. T., Rollo, M. & Li, W. (2015). mHealth diet and nutrition guidance. *mHealth Multidisciplinary Verticals*, 65.

Radcliffe, Damian. (2015) Mhealth in the Middle East. InnovateMedTec, accessible at https://innovatemedtec.com/content/mhealth-in-the-middle-east

Rasheed, P., Abou-Hozaifa, B. M., & Khan, A. (1994). Obesity among young Saudi female adults: a prevalence study on medical and nursing students. *Public Health*, *108*(4), 289-294.

Rasheed, P. (1998). Perception of body weight and self-reported eating and exercise behaviour among obese and non-obese women in Saudi Arabia. Public Health, 112(6), 409-414.

Renaud, K. and Van Biljon, J., 2008, October. Predicting technology acceptance and adoption by the elderly: a qualitative study. In *Proceedings of the 2008 annual research conference of the South African Institute of Computer Scientists an*d Information Technologists (pp. 210-219). ACM.

Rogers, E. M. (2010). *Diffusion of innovations*. Simon and Schuster.

Rogers, R. J., Lang, W., Barone Gibbs, B., Davis, K. K., Burke, L. E., Kovacs, S. J. & Jakicic, J. M. (2016). Applying a technology-based system for weight loss in adults with obesity. *Obesity Science & Practice*.

Rollo, M. E. (2012). An innovative approach to the assessment of nutrient intake in adults with type 2 diabetes: the development, trial and evaluation of a

mobile phone photo/voice dietary record (Doctoral dissertation, Queensland University of Technology).

Rose, G., D. Straub.(1998), Predicting general IT use: applying TAM to the Arab world, Journal of Global Information Management 6, 1998, pp. 39–46.

Salamati, F., & Pasek, Z. J. (2014). Personal wellness: complex and elusive product and distributed self-services. Procedia CIRP, 16, 283-288.

Saunders, M., Lewis, P., & Thornhill, A. (2003/2012) *Research method for business students*, 3rd/6th edition. New York: Prentice Hall.

Schnall, R., Higgins, T., Brown, W., Carballo-Dieguez, A., & Bakken, S. (2015). Trust, perceived risk, perceived ease of use and perceived usefulness as factors related to mHealth technology use. *Studies in health technology and informatics,* 216, 467.

Schoeppe, S., Alley, S., Van Lippevelde, W., Bray, N. A., Williams, S. L., Duncan, M. J., & Vandelanotte, C. (2016). Efficacy of interventions that use apps to improve diet, physical activity and sedentary behaviour: a systematic review. *International Journal of Behavioral Nutrition and Physical Activity*, *13*(1), 127.

Sekaran, U. (2003) *Research methods for business: A skill building approach.* John Wiley & Sons.

Sheikh, Z., Islam, T., Rana, S., Hameed, Z., & Saeed, U. (2017). Acceptance of social commerce framework in Saudi Arabia. Telematics and Informatics.

Silva, B. M., Rodrigues, J. J., de la Torre Díez, I., López-Coronado, M., & Saleem, K. (2015). Mobile-health: A review of current state in 2015. *Journal of biomedical informatics*, *56*, 265-272.

Sim, J. (1998). Collecting and analysing qualitative data: issues raised by the focus group. *Journal of advanced nursing*, 28(2), 345-352.

Srivastava, S. C., Chandra, S., & Theng, Y. L. (2010). Evaluating the role of trust in consumer adoption of mobile payment systems: An empirical analysis. *Communications of the Association for Information Systems*, *27*, 561-588.

Srivastava, L. (2005). Mobile phones and the evolution of social behaviour. *Behaviour & Information Technology*, *24*(2), 111-129.

Stawarz, K., Cox, A. L., & Blandford, A. (2015, April). Beyond self-tracking and reminders: designing smartphone apps that support habit formation. In *Proceedings of the 33rd annual ACM conference on human factors in computing systems* (pp. 2653-2662). ACM.

Straub, D., M. Keil, W. Brenner (1997) Testing the technology acceptance model across cultures: a three-country study. *Information & Management*, 33 (1997), pp. 1–11

Straub, D.W. K. Loch, C. Hill (2001), Transfer of information technology to the Arab world: a test of cultural influence modelling, *Journal of Global Information Management*, 9, 2001, pp. 6–28.

Suliman, M. T. (2014). Sending photos through WhatsApp: A faster method for teleconsultation. www.qscience.com/doi/pdf/10.5339/jlghs.2014.2

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*, 14(2), p.183.

Swan, M. (2009). Emerging patient-driven health care models: an examination of health social networks, consumer personalized medicine and quantified self-tracking. *International journal of environmental research and public health*, *6*(2), 492-525.

Swan, M. (2012). Sensor mania! the internet of things, wearable computing, objective metrics, and the quantified self 2.0. *Journal of Sensor and Actuator Networks*, *1*(3), 217-253.

Sweileh, W. M., Sa'ed, H. Z., Al-Jabi, S. W., & Sawalha, A. F. (2014). Quantity and quality of obesity-related research in Arab countries: assessment and comparative analysis. *Health Research Policy and Systems*, *12*(1), 33.

Swinburn .Ba ,Caterson.I, Seidell. Jc, James. Wpt .(2007). Diet, nutrition and the prevention of excess weight gain and obesity.*Public Health Nutrition*, 7(1a), 123–146. doi:10.1079/PHN2003585

STC, S. T. C. (2010). Communication services developments indicators: the period from1420/1421h until 1423/1424h (Arabic language). Riyadh.

Toda, M., & Morimoto, K. (2001). Health practice in Islam—The cultural dependence of the lifestyle formation—. *Environmental health and preventive medicine*, *5*(4), 131.

Tourkmani, A. M. (2004). Diabetes mellitus in Saudi Arabia: A major public health concern. *Saudi Med J*, *25*, 1603-10.

Tsang, S., Royse, C.F. and Terkawi, A.S., 2017. Guidelines for developing, translating, and validating a questionnaire in perioperative and pain medicine. Saudi journal of anaesthesia, 11(Suppl 1), p.S80.

University of Twente (2017) Health Belief Model. Accessed at https://www.utwente.nl/en/bms/communication-theories/sorted-by-cluster/Health%20Communication/Health_Belief_Model/

University of Virgina. (2017) http://data.library.virginia.edu/hierarchical-linear-regression/

van der Gaag J. (1995) . Private and Public Initiatives: Working Together for Health and Education, 3, 4.

Varshney, U. (2014). Mobile health: Four emerging themes of research. *Decision Support Systems*, *66*, 20-35.

Vasalou, A., Oostveen, A. M., & Joinson, A. N. (2012, February). A case study of non-adoption: the values of location tracking in the family. In *Proceedings of the ACM 2012 conference on Computer Supported Cooperative Work* (pp. 779-788). ACM.

Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management science*, *46*(2), 186-204.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS quarterly,* 425-478.

Venkatesh, V., Thong, J. Y., & Xu, X. (2012). Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS Quarterly*, *36*(1), 157-178.

Verkijika, S.F., 2018. Factors influencing the adoption of mobile commerce applications in Cameroon. Telematics and Informatics, 35(6), pp.1665-1674.

Walseth, K., & Fasting, K. (2003). Islam's view on physical activity and sport: Egyptian women interpreting Islam. *International Review for the Sociology of Sport*, *38*(1), 45-60.

Wang, Y. S., Wu, M. C., & Wang, H. Y. (2009). Investigating the determinants and age and gender differences in the acceptance of mobile learning. *British journal of educational technology*, *40*(1), 92-118.

Wang, Q., Egelandsdal, B., Amdam, G. V., Almli, V. L., & Oostindjer, M. (2016). Diet and physical activity apps: perceived effectiveness by app users. *JMIR mHealth and uHealth*, *4*(2).

Weber, A. S., Turjoman, R., Shaheen, Y., Al Sayyed, F., Hwang, M. J., & Malick, F. (2016). Systematic thematic review of EHealth research in the Gulf Cooperation Council (Arabian Gulf): Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and United Arab Emirates. *Journal of telemedicine and telecare*, 1357633X16647894.

World Atlas: 29 Most Obese Countries in the World. (2016). Retrieved from http://www.worldatlas.com/articles/29-most-obese-countries-in-the-world.html

World Health Organisation (2016a). Fact Sheet on Obesity. Downloadable at http://www.who.int/mediacentre/factsheets/fs311/en/

World Health Organisation (2016b). Atlas of EHealth Country Porfiles. Downloadable at http://www.who.int/goe/publications/atlas_2015/en/

World Health Organisation (2016c) Global diffusion of eHealth: making universal health coverage achievable. Report of the third global survey on eHealth. Licence: CC BY-NC-SA 3.0 IGO

Yi, M. Y., Jackson, J. D., Park, J. S., & Probst, J. C. (2006). Understanding information technology acceptance by individual professionals: Toward an integrative view. *Information & Management*, 43(3), 350-363.

Yu, P., Wu, M. X., Yu, H., & Xiao, G. Q. (2006, June). The challenges for the adoption of MHealth. In *Service Operations and Logistics, and Informatics, 2006. SOLI'06. IEEE International Conference on* (pp. 181-186). IEEE.

Yumak, Z., & Pu, P. (2013). Survey of sensor-based personal wellness management systems. *BioNanoScience*, *3*(3), 254-269.

Yusof, A. F. B., & Iahad, N. B. A. (2013, November). Theoretical model for continuance use of mobile phone wellness application. In *Research and Innovation in Information Systems (ICRIIS)*, 2013 (pp. 459-474). IEEE.

Zhao, J., Freeman, B., & Li, M. (2016). Can mobile phone apps influence people's health behavior change? An evidence review. *Journal of medical Internet research*, 18(11).

## Appendix One: Covering Letter

Subject: You are invited to a research survey – (Mobile applications for health)

Dear Participant,

You are invited to participate in a research study titled “Mobile applications for health”. This study is being conducted by Mousa Khubrani from the Department of Computing at University of Brighton, UK. The research concerns the factors that affect people’s acceptance and adoption of mobile health applications, like those pictured at the beginning of the survey.

This study follows the requirements of the Research Ethics panel of the University of Brighton. There are no risks associated with participating in this study. The survey collects no identifying information of any respondent. All of the responses in the survey will be recorded anonymously. While you will not experience any direct benefits from participation, information collected in this study may benefit individuals in the future by better understanding the factors that affect adoption and acceptance of mobile health.

In this study, you will be asked to complete an electronic survey. Your participation in this study is voluntary and you are free to withdraw your participation from this study at any time. The survey should take only 15 minutes to complete.

If you have any questions regarding the survey or this research project in general, please contact (Mousa Khubrani m.khubrani@brighton.ac.uk).

By completing and submitting this survey, you are indicating your consent to participate in the study. Your participation is appreciated.

(Mousa Khubrani), Doctoral Candidate, University of Brighton

**Please click on the survey link below and provide us with your feedback.**

**The link**

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## Appendix Two: Survey – English translation

(Note – references to previous studies and model constructs, e.g. EE, PE, were not included in the actual version given to respondents)

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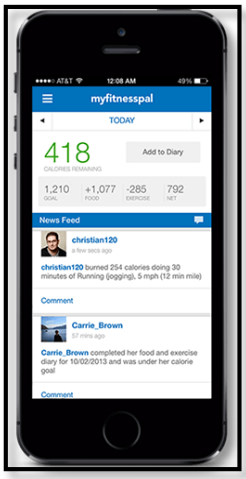
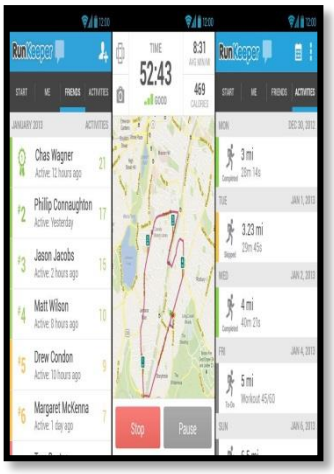
Examples of the types of app that participants will be asked about:





## Section 1 About You

**What is your age?**

- 25 or under
- 26-40
- 41-55
- 56 or older

**What is your gender?**

- Female
- Male

**Which of the following best describes the area you live in?**

- Urban
- Suburban
- Rural

**How long have you been using your smartphone, or your tablet?**

- Less than 6 months
- 6 to 12 months
- 1 to 3 years
- 4 to 6 years
- 7 years or more

### Your Attitudes to Technology

Please use the following table to express how ready you would be to adopt a new technology in your weight management. Tick the box next to the description that most reflects your approach to the adoption of new technology, especially related to the adoption of the fitness apps.

| | |
|---|---|
| | I tend to be a risk-taker and active-information seeker. I am willing to invest time and energy to learn and adapt quickly to new technologies. I tried using the fitness apps as soon as it was available, and shared my experience with others. |
| | I would explore the fitness app for its potential to bring about improvements in my weight management. I am willing to try new things, and am not averse to occasional failure. However I want to see someone else using the fitness app successfully before I adopt it. |

| | |
|---|---|
| | I would adopt a “wait and see” attitude toward the fitness app, and wanted examples of close- to- home successes before adopting. I wanted to see the value of the fitness before adopting it. I wanted to make sure that adoption would be easy and hassle- free and that I would have the necessary technical support and advice to learn/use the fitness app. |
| | I would be sceptical about using the fitness app and accept it later in the game once it had become established among the majority of people around me and the institutional norms favoured adoption. |
| | I am usually not interested in adopting new technology and see no use for adopting the fitness app in my weight management, which has worked well so far. |

**Have you used a fitness app?**

No ☐

Yes ☐

Don’t know/can’t remember ☐

If YES, have you used one of the above fitness apps? If so, which one(s)?

If not please write the name of any app that you use.

What is your current frequency of use of mobile health services?

Have not used ☐

(ii) once a year ☐

(iii) once in six months ☐

(iv) Once in three months ☐

(v) Once a month ☐

(vi) Once a week ☐

(vii) Once in 4–5 days ☐

(viii) Once in 2–3 days ☐

(ix) Almost every day ☐

(x) Every day ☐

(xi) Several times a day ☐

**Performance Expectancy (PE) (Venkatesh, Thong & Xu, 2012)**

| | | | | | |
|---|---|---|---|---|---|
| Using [a/this] Fitness app [would] increase[s] my chances of becoming fitter . | ○ | ○ | ○ | ○ | ○ |
| Using [a/this] Fitness app [would] help[s] me to prevent being over-weight . | ○ | ○ | ○ | ○ | ○ |
| Using [a/this] Fitness app [would] help[s] me to manage my weight. | ○ | ○ | ○ | ○ | ○ |
| [A/This] Fitness app [would be/is] useful in my daily life. | ○ | ○ | ○ | ○ | ○ |

**Effort Expectancy (EE) (Venkatesh, et al. 2012)**

| | | | | | |
|---|---|---|---|---|---|
| Learning how to use [a/this] Fitness app [would be/is] easy for me. | ○ | ○ | ○ | ○ | ○ |
| My interaction with [a/this] Fitness app [would be/is] clear and understandable | ○ | ○ | ○ | ○ | ○ |
| I [would] find [a/this] Fitness app easy to use. | ○ | ○ | ○ | ○ | ○ |
| It [would be/is] easy for me to become skilful at using [a/this] Fitness app. | ○ | ○ | ○ | ○ | ○ |

**Social Influence: Friends and relatives (SIfr) a (Venkatesh, et al. 2012)**

| | | | | | |
|---|---|---|---|---|---|
| Friends and relatives who are important to me think I should use [a/this] Fitness app. | ○ | ○ | ○ | ○ | ○ |
| I [would] use [a/this] Fitness app because of the proportion of friends and relatives who use such an app. | ○ | ○ | ○ | ○ | ○ |
| Friends' and relatives' suggestions [will] affect my decision to use [a/this] Fitness app. | ○ | ○ | ○ | ○ | ○ |

**Social Influence: Healthcare specialists (SIsp) a (Venkatesh, et al. 2012)**

| | | | | | |
|---|---|---|---|---|---|
| Specialists (i.e. physicians, pharmacy, health insurance) think I should use [a/this] Fitness app. | ○ | ○ | ○ | ○ | ○ |

| | | | | | |
|---|---|---|---|---|---|
| I [would] use [a/this] Fitness app because a specialists recommended it to me. | ○ | ○ | ○ | ○ | ○ |
| Specialists' support and expertise [will] affect my decision to use [a/this] Fitness app. | ○ | ○ | ○ | ○ | ○ |

**Facilitating Conditions (FC) a (Venkatesh, et al. 2012)**

| | | | | | |
|---|---|---|---|---|---|
| I [would] have the resources necessary to use [a/this] Fitness app. | ○ | ○ | ○ | ○ | ○ |
| I [would] have the knowledge necessary to use [a/this] Fitness app. | ○ | ○ | ○ | ○ | ○ |
| [A/This] Fitness app is compatible with other technologies I use. | ○ | ○ | ○ | ○ | ○ |
| I can get help from others when I have difficulties using [a/this] Fitness app. | ○ | ○ | ○ | ○ | ○ |

**Hedonic Motivation (HM) a (Venkatesh, et al. 2012)**

| | | | | | |
|---|---|---|---|---|---|
| Using [a/this] Fitness app [would be/is] fun. | ○ | ○ | ○ | ○ | ○ |
| Using [a/this] Fitness app [would be/is] enjoyable. | ○ | ○ | ○ | ○ | ○ |
| Using [a/this] [would be/is] very entertaining. | ○ | ○ | ○ | ○ | ○ |

**Price Value (PV) b (Venkatesh et al., 2012; El-Wajee, Galal-Edeen& Mokhtar, 2014)**

| | | | | | |
|---|---|---|---|---|---|
| I would use a fitness app if it were reasonably priced. | ○ | ○ | ○ | ○ | ○ |
| Fitness apps would be more likely to provide a good value of weight management for money. | ○ | ○ | ○ | ○ | ○ |
| At reasonable price, fitness app will provides good value of my weight management. | ◉ | ○ | ○ | ○ | ○ |

**Price Value (PV) c (Venkatesh et al., 2012; El-Wajee, Galal-Edeen& Mokhtar, 2014)**

| | | | | | |
|---|---|---|---|---|---|
| Fitness apps are reasonably priced. | ○ | ○ | ○ | ○ | ○ |

| | | | | | |
|---|---|---|---|---|---|
| Fitness apps are a good value for money. | ○ | ○ | ○ | ○ | ○ |
| At the current price, fitness app provides good value of my weight management. | ○ | ○ | ○ | ○ | ○ |

**Habit (HAB) c (Venkatesh, et al. 2012)**

| | | | | | |
|---|---|---|---|---|---|
| The use of fitness app has become a habit for me | ○ | ○ | ○ | ○ | ○ |
| I am addicted to using fitness app | ○ | ○ | ○ | ○ | ○ |
| I [have to/would] use [this/a]. | ○ | ○ | ○ | ○ | ○ |
| Using fitness app has become natural to me | ○ | ○ | ○ | ○ | ○ |

**Initial Usage Intention (IUI) b (Venkatesh, et al. 2012)**

| | | | | | |
|---|---|---|---|---|---|
| I intend to use a fitness app in the next 30 days. | ○ | ○ | ○ | ○ | ○ |
| I predict I would use a fitness app in the next 30 days. | ○ | ○ | ○ | ○ | ○ |
| I plan to use a in the next 30 days. | ○ | ○ | ○ | ○ | ○ |

**Continued Usage Intention (CUI) c (Bhattacherjee, 2001)**

| | | | | | |
|---|---|---|---|---|---|
| I intend to continue using this fitness app rather than to discontinue its use. | ○ | ○ | ○ | ○ | ○ |
| I intend to continue using this fitness app rather than using any alternative. | ○ | ○ | ○ | ○ | ○ |
| I will not discontinue my use of this fitness app. | ○ | ○ | ○ | ○ | ○ |

**Additional factors relevant for health app usage**

**Trust in the App Developer (TRU) a (Akter, D'Ambra & Ray, 2011)**

| | | | | | |
|---|---|---|---|---|---|
| I [would] trust [an/this] app to provide reliable information and functions. | ○ | ○ | ○ | ○ | ○ |
| I [would] trust [a/this] fitness app promises and commitment to satisfy my health needs to manage my weight. | ○ | ○ | ○ | ○ | ○ |

| | | | | | |
|---|---|---|---|---|---|
| I [would] trust [a/this] fitness app to meet my expectations. | ○ | ○ | ○ | ○ | ○ |

**Perceived Privacy Risks (PR) a (Escobar-Rodriguez & Carvajal-Trujillo, 2014)**

| | | | | | |
|---|---|---|---|---|---|
| I am concerned that [a/this] fitness app [would] collect[s] too much personal information from me. | ○ | ○ | ○ | ○ | ○ |
| I am concerned that [a/this] fitness app [would] use[s] my personal information for other purposes without my authorization. | ○ | ○ | ○ | ○ | ○ |
| I am concerned that [a/this] fitness app [would] share[s] my personal information with other entities without my authorization. | ○ | ○ | ○ | ○ | |
| I am concerned that unauthorized persons (i.e. hackers) [would] have access to my personal information. | ○ | ○ | ○ | ○ | |
| I am concerned that using [a/this] fitness app [would] cause[s] me to lose control over my information. | ○ | ○ | ○ | ○ | |

**Valuation of Health (VH) a (self-developed scale)**

| | | | | | |
|---|---|---|---|---|---|
| The condition of my health would be better if I followed a healthy lifestyle. | ○ | ○ | ○ | ○ | ○ |
| The condition of my health is important to me. | ○ | ○ | ○ | ○ | ○ |
| Following a healthy lifestyle would have a positive impact on my future health. | ○ | ○ | ○ | ○ | ○ |
| It is important to me to follow a healthy lifestyle. | ○ | ○ | ○ | ○ | ○ |

Please include any additional comments on this section (optional):