Factors Influencing Acceptance and Continued Use of mHealth Apps

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Abstract. By 2018, mHealth apps would have been downloaded by 50% of the more than 3.4 billion global smartphone and tablet users. As existing challenges to adoption are allayed, empirical evidence for factors that most predict successful adoption of mHealth apps will be useful to inform and guide the trajectory of mHealth development. To date, most research has looked into clinician perception of mHealth apps. However, only 2% of mHealth apps target healthcare providers/insurance, while the remainder target patients and other consumers [1]. This study was conducted to examine the following: What factors predict adoption of mHealth apps? Participants (n = 11) between ages of 18 to 65 were recruited. A cross-sectional, qualitative interview methodology was used to investigate the research question. The UTAUT2 model for technology adoption and continued use was used to inform the interview guide. Closed coding, thematic analysis and co-occurrence analysis were performed to identify factors. Performance expectancy, effort expectancy and habit were the most relevant constructs that predict adoption of mHealth apps. Flexibility of app to personal preferences positively contributes to performance expectancy. Usage of a specific feature is influenced by user's assessment of relevance to subjective overall health, or interest. Perception of limited features/value may lead to user boredom and use discontinuation. Social influence and hedonic motivation were the least directly implicated factors. Most participants were unwilling to purchase apps before a trial period. Emergent factors include trust for technology/information, required time for interaction with app, privacy of personal information/data, and app-generated feedback.

Keywords: mHealth · mHealth app · UTAUT2 · Technology adoption

1 Introduction

Widespread global adoption and use of mobile communication technology has led to a new phenomenon: mobile health (mHealth). mHealth has a unique potential to "transform the face of health service delivery across the globe" and enhance health outcomes, health quality, and health equity [2]. Telemedicine is an example of successful mHealth implementation that has extended the reach of healthcare specialists to geographically restricted patients who would otherwise not receive adequate care.

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Earlier roles for mobile phones in healthcare include use of text messaging to promote healthy behaviours and to bring awareness to disease outbreaks using mass alerts [3]. Owing to expanded functions compared to former mobile phone generations, smartphones provide a platform for mHealth software (mHealth apps). mHealth apps are software that are designed to encourage illness self-management, to promote wellness and health education as well as to assist health care professionals in making diagnostic and treatment decisions [4, 5].

The current volume of mHealth apps exceeds 100,000 and continues to grow (6). It is estimated that, by 2018, mHealth apps will be downloaded by 50% of the more than 3.4 billion global smartphone and tablet users [6]. Notwithstanding the impressive growth trends, evidence for subsequent healthcare gains remain scarce. mHealth apps spur several concerns including quality and validity of content, medicolegal ramifications and risks to privacy and security [7, 8]. High turnover rates will likely add challenge to the assessment of effectiveness and clinical utility of mHealth apps. A recent US national survey of mobile phone use showed that approximately 58% of respondents used mHealth apps and, of those, 45.7% reported past discontinuation of mHealth apps use for reasons including "high data entry burden, loss of interest, and hidden costs" [9]. As regulatory frameworks become more established and existing concerns are allayed, factors that most predict successful adoption of mHealth apps will be useful to inform and guide the trajectory of mHealth app development.

To date, most research has looked into clinician perception of mHealth apps. However, only 2% of mHealth apps target healthcare providers/insurance, while the remainder target patients and other consumers [1]. Using the UTAUT2 model for consumer technology adoption studies, this qualitative study examined the following question: What factors determine the adoption and use of mHealth apps for personal use by healthcare consumers?

2 Literature Review

mHealth apps have the capacity to alter the scale and scope of healthcare services. Considering the ubiquity and portability of smartphones, the ease of access to the primary distribution channels of mHealth apps, i.e., app stores, and the low levels of technology literacy required for their use, mHealth apps are uniquely positioned to improve the quality and cost effectiveness of preventative care as well as treatment and management of medical conditions [10]. mHealth apps are also uniquely positioned to address issues of health inequities [11].

2.1 Filling Gaps in Healthcare

Illness Detection: Benefits of Healthcare any Time, any Place: mHealth apps can play an important role in early detection of medical conditions, reduction of illness burden as well as healthcare spending. Some medical conditions can be difficult to detect early at a doctor's office due to the unpredictability of the timing of symptom

occurrence. For example, symptoms of atrial fibrillation, a heart condition marked by heart arrhythmia, may not occur during traditional ECG procedures. mHealth apps can lead to early treatment and better health outcome by allowing for detection of the condition in a non-clinical setting by virtue of ease of access to medical device, i.e., smartphone, and low cost barrier to app use [10].

Prevention of Illness Exacerbation: mHealth apps can assist in the prevention of illness exacerbation. For example, lack of time and financial constraints have been identified as reasons for individuals with chronic obstructive pulmonary disease (COPD) to delay seeking healthcare services [12]. A study reported that "the hospitalization costs for the treatment of acute COPD exacerbations represented about 45% of total costs" [12]. mHealth apps designed to support self-management of illness symptoms may help improve quality of life, reduce the frequency of hospitalization, and improve financial efficiency [12, 13].

Management of Chronic Conditions: Chronic conditions are often complex, require ongoing clinical care, and may also require self-management by ways of lifestyle changes, treatment adherence. mHealth apps can be useful in the management of chronic conditions. For example, decision support apps for diabetes can be designed to provide just-in-time guidance according to blood glucose levels, to calculate insulin bolus doses, as well as to track diet, physical exercise, and medication regimens [14, 15]. mHealth apps could be particularly useful in times when a healthcare provider cannot be reached or when the nature of their queries do not justify reaching out to a healthcare provider [15].

2.2 Cross-Generational Reach: From Pediatric to Geriatric Healthcare Consumers

Pediatric Population: Twelve percent of children between the ages of 8 to 12 and 37% of adolescents between the ages of 12 to 18 own smartphones [16]. In 2014, a minimum of 60% of children used apps by age 8 [16]. mHealth apps can, therefore, be a viable route to overcoming the challenge of engaging the pediatric population outside the healthcare setting and encouraging self-management. For example, children and adolescents in therapy for pain management can get easy access to reinforcement of pain management skills even when not in a therapist's office, thereby leading to improved health outcomes and quality of life [16]. A separate pilot study was able to show that a gamified diabetes app increased the frequency of blood glucose level assessment among adolescents with type I diabetes [17].

Elderly Population: Given the high prevalence of chronic illness in the elderly population, and the complexities often associated with their conditions, mHealth apps can assist the elderly population in self-management. Use of smartphones among individuals over the age of 65 is low. In 2013, only 18% owned a smartphone and over 25% of those who have smartphones never downloaded an app [11]. However, once familiarized with a new technology, individuals in this age group are reported to be frequent users of technology compared to younger individuals [11].

2.3 Technology Adoption and Use

Empirical evidence for the "real world" effectiveness of mHealth apps in healthcare is scarce. Various technology adoption models have been used to guide research design, data collection, as well as explanation of findings in studies of mHealth adoption.

A survey of 343 Korean adults based on the Post-Acceptance Model (PAM) and Technology Acceptance Model (TAM) showed that confirmation of a consumer's initial expectations of an mHealth app was a positive and significant predictor of perceived usefulness (PU), perceived ease of use (PEOU) and intention-to-use the app [18]. Furthermore, while both PU and PEOU predicted intention-to-use, only PEOU had significant influence on Satisfaction with the mHealth app [18]. A separate survey study based on the TAM framework conducted across universities in Bangladesh (n = 144) found different results where PU, and not PEOU, predicted intention-to-use [19]. Interestingly, the study found that PEOU was significantly associated with PU. The study also showed that intention-to-use was significantly and positively associated with actual use of mHealth.

A survey of 1,132 US consumers using a combination of theoretical constructs on "technology adoption, technology assimilation, consumer behaviour, and health informatics literature" showed that perceived innovativeness toward mobile services (PIMS) and perceived health conditions had a direct impact on intention-to-use [20]. Co-presentation of high PIMS with high perceptions of healthiness or high perceptions of vulnerability to chronic disease was significantly associated with increased levels of mHealth "assimilation and substitutive use" wherein substitutive use is defined as preference for mHealth use as compared to doctor visits. Co-presentation of high PIMS with high perception of healthiness was also significantly associated with adjunctive use of mHealth in addition to visits to the doctor [20].

A separate study used the value-attitude-behaviour model, theory of planned behaviour and aging characteristic factors to survey 424 Chinese adults over 40 years of age [21]. The results showed that subjective norm, i.e., a "person's perception that most people who are important to him think he should or should not perform the behaviour in question", and perceived physical condition did not influence intention-to-use mHealth apps. However, the predictive factors of intention-to-use differed between middle-aged and older users. Attitude (strongest), perceived value, perceived behaviour control and resistance to change (weakest) were positive predictors of intention-to-use among the middle-aged group. However, perceived value, attitude, perceived behavior control, technology anxiety, and self-actualization need were significant predictors of intention-to-use among the older group. Results also showed positive relationship between perceived value and attitude in both groups.

Using the UTAUT2 model, a survey of 317 college-aged users showed that performance expectancy, hedonic motivation, and habit positively predicted user's intention-to-use of a health and fitness app, whereas effort expectancy, social influence, facilitating conditions, and price value were positively, but not significantly, associated to intention-to-use [22]. The authors argued that the insignificant effect of effort expectancy may be due to a ceiling effect resulting from the study population's high

comfort-level with the technology and the high level of usability of device interfaces [22]. While price value did influence intention-to-use, the authors suggested that participants would discontinue use of free apps that add no subjective value, whereas they would be willing to pay for apps that they find valuable [22].

A systematic literature review revealed that the main recognized factors that influence mHealth adoption are: 'perceived usefulness and ease of use, design and technical concerns, cost, time, privacy and security issues, familiarity with the technology, risk-benefit assessment, and interaction with others' [23].

3 Methods

3.1 Research Model

The UTAUT2 was selected as the model of choice in this study for the following reasons: (1) It has comparatively better explanatory power; (2) It is best positioned to explore use behaviour from consumer context rather than an organizational context. Table 1 lists UTAUT2 constructs and their definitions.

The UTAUT model explains 69% of technology acceptance, i.e., intention-to-use, when compared to prior models that explained approximately 40% of the phenomenon [24]. However, since its publication, only 16 studies used the full theory in its original form which is suggestive of the non-suitability of the theory across all contexts [25]. The UTAUT was developed for the organizational context where users may be required to use technology. An extended version of this model, the UTAUT2, includes additional core constructs to emphasize the consumer context where technology adoption is voluntary.

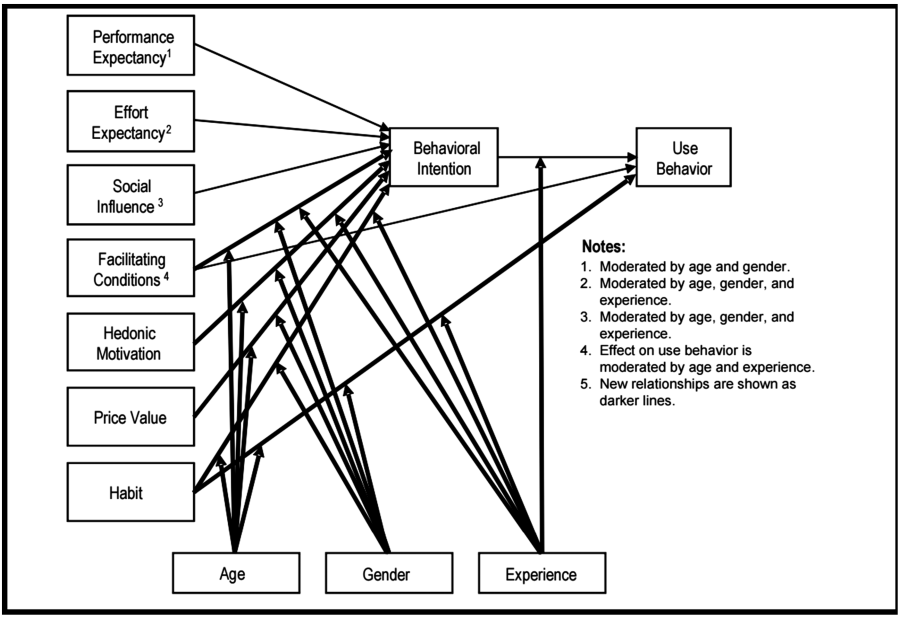
Table 1. UTAUT2 Constructs and their definition

Construct	Definition
Performance expectancy [24]	"The degree to which an individual believes that using the system will help him or her to attain gains in job performance"
Effort expectancy [24]	"The degree of ease associated with the use of the system"
Social influence [24]	"The degree to which an individual perceives that important others believe he or she should use the new system"
Facilitating conditions [24]	"The degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system"
Hedonic motivation [26]	"The fun or pleasure derived from using a technology"
Price value [26]	"The cost and pricing structure"
Habit [26]	"The extent to which people tend to perform behaviours automatically because of learning"

3.2 Research Propositions

The following propositions were evaluated as part of this research study:

P1: Performance Expectancy influences Behavioural Intention and Use Behaviour.
P2: Effort Expectancy influences Behavioural Intention and Use Behaviour.
P3: Social Influence influences Behavioural Intention and Use Behaviour.
P4: Facilitating Conditions influences Behavioural Intention and Use Behaviour.
P5: Hedonic motivation influences Behavioural Intention and Use Behaviour.
P6: Price Value influences Behavioural Intention and Use Behaviour.
P7: Habit influences Behavioural Intention and Use Behaviour.



Retrieved from: Venkatesh, V., Thong, J.Y.L., Xu, X. (2012). Consumer acceptance and use of information technology: Extending the Unified Theory of Acceptance and Use of Technology. Vol. 36 No. 1 pp. 157–178..

3.3 Research Design, Data Collection and Analysis

This exploratory qualitative research study employed semi-structured interviews to obtain in-depth information from individuals who have adopted mHealth apps for personal use. An interview guide was developed by adapting previously validated questions from the UTAUT2 framework for consumer technology acceptance. Socio-demographic characteristics collected include age, sex, education, marital status, and household income. The interviewer obtained informed consent from all participants

prior to conducting the interview. Ethics approval for the study was obtained from the Ryerson University Research Ethics Board.

Participants were recruited through face-to-face invitation at a doctor's office in the community. One-time semi-structured interviews were conducted using an interview guide. Interviews were digitally audio-recorded and transcribed verbatim. Data immersion, coding and content analysis was conducted to identify themes. The NVivo software supported the data analysis which included: (1) a closed coding deductive method using UTAUT2 concepts; (2) thematic analysis and open coding, an inductive method to identify factors not considered in UTAUT2; and (3) co-occurrence analysis.

4 Findings and Discussion

Individuals (n = 11; 3 males, 8 females) between the ages of 18 and 65 were interviewed as part of this study. Fitness and women's mHealth apps were the most prevalent mHealth apps, followed by general health apps. (see Tables 2 and 3).

Most participants (n = 8) had a single mHealth app installed on their mobile device at the time of interview. A possible explanation is that mHealth apps compete between themselves and other non-health apps for user's time. The Nielsen company, a consumer trends research company, reported that while the average smartphone user had 42 apps installed on their devices, 87% of those users declared that they use less than 10 apps in any given day [27]. Another possible explanation is that users conduct targeted search for apps that they predetermine as relevant to their specific interests or health needs.

Table 2. Demographic characteristics of participants.

Variable	Categories	n	%
Age	18–24	2	18.2
	25–29	3	27.3
	30–39	3	27.3
	40–49	1	9.1
	50–59	1	9.1
	60–65	1	9.1
Sex	Female	8	72.7
	Male	3	27.3
Marital status	Single	8	72.7
	Married	3	27.3
Education	High school	3	27.3
	Some college	2	18.2
	Undergraduate	5	45.5
	Some post-graduate	1	9.1
Household income	Under 35, 000	1	9.1
	35,000–50,000	3	27.3
	50,000–75,000	6	54.5
	75,000–100,000	1	9.1

Table 3. Description of device and mHealth apps

Variable	Categories	n	%
Device type	iPhone	6	54.5
	Android	5	45.5
No. of mHealth apps	1	8	72.7
	2	1	9.1
	3	1	9.1
	5	1	9.1
Types of mHealth apps	Healthy diet (incl. Weight loss)	2	18.2
	Fitness	5	45.5
	Women's health	5	45.5
	General health	4	36.4
	Rest & Relaxation (incl. Mental health)	1	9.1

4.1 Performance Expectancy

Generally, participants agreed that mHealth apps served their desired purposes. The following sub-themes emerged in relation to the concept of performance expectancy.

Time-Demand
Most users interacted with their mHealth apps for up to 15 min per day during days of use. Where apps are intructional/educational or where they support activities like meal-planning and diet tracking, participants interacted with apps for 30 min or more. Most participants (n = 10) reported that they had no desire to spend more time on mHealth apps than they already did. Only one person reported a desire for increased and regularized usage and identified low user-friendliness of the app as a deterrent.

Scope of Content
mHealth apps with limited, easily exhaustible scope of content may cease to be of value to the user after a certain period of time, particularly when they are designed for instructional purposes. One participant described an instructional fitness app, a cost-saving substitute for a personal trainer, that lost its usefulness once the full content was covered.

> *[Interviewee #04] ... I just deleted it because I'm like, I know what I'm doing now, there's nothing more.*

App Accuracy
Two multiple app users expressed disappointment with the performance of women's health apps. Both expressed a misguided expectation of predictive accuracy which highlights the importance of incorporating guiding material where necessary. Both reported deleting the apps and re-installing them at a later time. The implication is that perceived value impacts effort to learn. In contradistinction, three other users felt that the apps performed well for the task. Another participant continued use of the app after finding discrepancies in app-generated measurements.

Scope of Flexibility

One multiple app user reported that while a diet app performed as expected, i.e., provided information on healthy dietary options, the app lacked the flexibility to adjust to ethnic preferences. Nonetheless, she reported continued use to promote her weight loss and to guide healthy meal preparations for her family.

[Interviewee #06] ...It wasn't to my liking…for ethnic reasons, there're cenrtain things we don't really eat or never eaten before.

Another user expressed satisfaction with the large database supported by her diet app of choice and its flexibility, i.e., ability to recognize her entries.

[Interviewee #07] ...it has a huge database. So anything, I can even put the most obscure thing, if I'm making my own spinach egg-drop soup, someone somewhere in the world seems to have entered it…

App-Generated Feedback

Perceived quality of app-generated feedback was a common factor among three participants who reported that app performance exceeded expectations. App-generated feedbacks increased user awareness of existing behavioural patterns and encouraged behaviour modification for better personal health outcomes.

[Interviewee #05] ...fell in love with it. Cause it basically, if for whatever day I'm kinda feeling like a bit drowsy or down or you know like a bit tired then I know exactly why, cause I haven't really gotten enough sleep. I can actually see that on like a chart in front of me so it kinda measures it, right.

[Interviewee #07] …you track your weight daily and it does statistics, like it does like charts and it sends you daily little reports that you can print out, like actual reports well it will do everything for you including, weekly, how much, in a pie graph, you've been consuming in terms of carbs, fats and things like that and even your habits…

[Interviewee #11] I just always assumed that when I was sleeping, it was solid. It's not. So sometimes, you're like, oh I got 6 h last night, and then you sync your [device/app] and like no you got like 4 cause you were tossing and turning or you woke up multiple times…

Potential for Harm

Most users did not see harm in using mHealth apps. However, two potential harmful effects of mHealth apps were identified: anxiety in response to app-generated information, and propagation of clinically unsupported behaviours that may jeopardize users' health.

One participant recounted a time of significant concern over 'inaccurate' predictions of a women's mHealth app. She added that her friend had gone through a similar situation.

[Interviewee #04] "…when I got really scared, I just deleted the app…"

One individual highlighted the potential harm of mHealth apps that promote extreme calorie restriction diet programs that would normally be monitored by a health care provider.

[Interviewee #07] "…it's a controversial diet…"

Other Detractors of Performance Expectancy
Dependency on WiFi and functional errors were also reported to negatively affect performance expectancy.

4.2 Effort Expectancy

In general, participants were able to use mHealth apps with ease. One out of five users of womens health apps reported deleting an app after difficulty with data entry. The participant reinstalled the app at a later time and sought assistance from friends. The participant indicated that low perceived ease of use is a significant motivator for searching for alternative mHealth apps. Another participant expressed intention to reinstall a fitness app she had previously deleted after finding it comparatively more user-friendly than an alternative app.

[Interviewee #06] "I didn't know how to change the [date] so I deleted the app and I downloaded it again."

[Interviewee #06] "If I can't use one I just delete it. Find one that's much easier."

[Interviewee #08] "…there was another one that I had….I think I like that one a little bit more because it was a little bit more user-friendly."

Most users do not use all the features of mHealth apps. Their usage is influenced by their assessment of relevance to their overall health, their interest, or the effort required to use the features. However, most expressed desire to further explore the apps in the future.

[Interviewee #01] "There is an option to check how much water do you drink, your calorie tracker. I don't use those. I only check the…more related to my….heart rate…and my steps to check my body condition."

[Interviewee #06] "There is more stuff there. Yet to discover when I have the time."

[Interviewee #11] "Predominantly laziness, I think what it comes down to. Just because it's a lot of work for some things."

Presence of more features did not detract from effort expectancy. On the contrary, the availability of more features in mHealth apps may serve to maintain the user's interest in the app. As previously mentioned, limited number of app features risk user boredom and disengagement.

[Interviewee #07] "There is something about having so much variety offered to you. You know. It makes it somehow more enjoyable."

4.3 Social Influence

Most participants learned of mHealth apps through browsing app stores and through YouTube advertisements/reviews. One user indicated that a TED Talk presentation

may have been her introduction to a mHealth app. Two users reported that casual conversations sparked initial curiosity for specific types of mHealth apps that they later downloaded.

Approximately half of the participants had friends and family who use the same or closely similar apps. However, most users did not receive encouragement to use mHealth apps.

[Interviewee #06] "through my girlfriends. One of them was my sister-in-law, the other one was my soccer partner and the other one is my friend."

Only one of 11 participants reported mHealth app adoption as a consequence of direct social influence, that is, she expressed being embarrassed for being the last among her friends to adopt a women's health app.

[Interviewee #06] "I didn't know, I was laughed at because they knew about it, and I didn't know about it."

Only one participant reported use of mHealth app to track information in anticipation of questions from her healthcare provider.

4.4 Facilitating Conditions

Most users (n = 7) would turn to the internet, i.e., Google, YouTube, and online forums, as the primary tool for troubleshooting issues related to mHealth apps. Three participants indicated that they would seek help from friends and family. One participant indicated that in-app instructions were sufficient. Three partipants revealed app deletion and replacement with a more user-friendly app as a method of problem resolution.

[Interviewee #04] "There was one time I [tried to figure it out] but then it ws so confusing."

[Interviewee #04] "If I can't use one I just delete it. Find one that's much easier."

A limitation in interpreting this observation is that all, with the exception of two users, had never paid for mHealth apps and, therefore, were not faced with switching costs. A study found that the role of switching costs are significant in cases of above average customer satisfaction or perceived value [28]. It may, therefore, be conjectured that, where users are otherwise satisfied with an app, as the price for apps increase, the availability of facilitating conditions becomes increasingly relevant to switching costs.

4.5 Hedonic Motivation

Six out of 11 participants reported that there was nothing they didn't like about the mHealth apps they use. Nonetheless, only three participants brought up enjoyment in the context of in-app community competitions that promoted weight loss or physical fitness.

[Interviewee #05] "...they have like a bunch of different competitions that you can participate in with your friends, with your buddies, right and you can create that crew."

It is important to note that, by and large, participants commented on the app's performance and effort expectancy when asked about the likeability and enjoyability of an mHealth app. Participants associated absence of hedonic motivation with app dysfuntion (i.e., glitches), absence of variety in app features (i.e., boredom), absence of specific useful features (i.e., reminder notifications), insufficient ease of use, and app-dependence on internet. One participant quipped, "You won't use an app for fun." It, therefore, appears that user's perception of hedonic motivation overlaps with performance expectancy in the context of mHealth apps. This is not to mean that mHealth app appeal is not relevant in the selection of one app over another with similar function. When asked what pushed her to download a particular app, one participant replied:

[Interviewee #11] "Probably because I like the little logo."

4.6 Price Value

All participants used free apps and only 3 had purchased apps in the past. It was, therefore, not possible to assess users' attitude towards price value. However, two main sub-themes surfaced.

Willingness to buy
Most users (n = 8) were willing to pay for apps that they have tried and know work well for them. In some cases, users would prefer to compare apps against familiar, previously established tools before making a purchase.

[Interviewee #06] "I would pay for it because I am satisfied with it…I would prefer that applications have a trial period …to see that it would fit your needs."

[Interviewee #03] "…I didn't trust it. When I come now to the doctor, when I checked the app and the [results] she gave me [after] she check it, they are equal. I like it. After this, I am going to use it."

Two participants who used mHealth apps in conjunction with an activity tracking device expressed that, in spite of the presence of additional features, the apps' value would be lost to them in the absence of the device. The convenience of low level interaction and continuous tracking of measures of physical activity and sleep quality was one of the main appeals of using the mHealth device/app combination. The added features in the apps, including tracking of diet and hydration, were of less appeal due to the level of engagement required for regular data entry.

It is unsurprising that the willingness to pay for an app also depends on the availability of a free alternative.

[Interviewee #11] "…but if there are free ones, I'm not going to pay for this one."

Three participants reported unwillingness to purchase apps; one of them stressed that she would not pay for an app but would search for a free alternative, highlighting the low switching cost for many mHealth apps. Another admitted her overall low interest in technology and therefore, low likelihood to pay for mHealth apps, the third expressed high doubts on reliability of app as deterrent to making a purchase.

Role of Trial Periods

Upfront fees for access may hamper app sales. All 3 participants who had bought apps in the past expressed post-purchase regrets. One participant pointed out her preference for lite versions of apps that offer a time-locked trial period for full access rather than those that require upfront payment for premium access. She contrasted her decision to purchase a "gimmicky" app after an effective trial period against a separate decision to not pay for premium access to an app with free lite version due to uncertainty of additional value.

> *[Interviewee #11] "I honestly don't like the idea of a membership where you have access to everything for this amount of money. Give me something where I can say look I want this one, this one, and this one. I will pay, you know, maybe pick 3 programs or something and then say ok you have a 3 month subscription for these 3 programs for like what $10. I can do something like that. I just don't like paying such a big chunk of money for a bunch of stuff I in there that I am probably never going to use."*

Another participant reported that she was satisfied with the free lite version of the app and was not convinced of the added value of the premium version of the app. Her position was also influenced by past dissatisfation with purchased premium access to an app.

> *[Interviewee #07] "I don't know if it actually is worth it. I don't understand what the benefits are…I found what I have is great so I don't know what they're really offering me that would step it up."*

> *[Interviewee #07] "..,you get it and it's not that much, there is no difference between this and the lite version"*

mHealth apps are a relatively new phenomena and, therefore, trial periods may play an important role in dynamic pricing [29]. The valuations of mHealth apps by all but one participant ranged from $2–$15. However, two of those individuals use their apps in conjunction with an activity tracking device which is relatively costly. One person was an outlier in his willingness to pay as much as $50 for a general health app that makes accurate measurements and reasoned by saying that it was for his health, after all. Some app developers are likely using this pricing strategy. One participant was fairly certain that the price of an app that she purchased after a successful trial period, cost more at time of interview than when she bought it.

4.7 Habit

All but one participant were content with the frequency with which they use mHealth apps. The exception attributed inconsistency of use to dissatisfaction with user-friendliness of the app.

About half of the participants found reminder push notifications useful. One participant expressed disappointment that an app did not have reminders. Two participants indicated that too many reminders may alienate rather than retain them as users of mHealth apps. One of the two appreciated that the app gives her a nudge when she does not use the app for some length of time. The other opined that the usefulness of push

notification reminders would be dependent on the type of mHealth app and the ability to customize over time.

[Interviewee #07] "If it did bother me every day, I'd feel hounded…[when there's a time gap] it's like when you want someone to notice you or something. Like a friend."

[Interviewee #11] "In reality, probably, I'd just get frustrated and be like leave me alone."

4.8 Behavioural Intention

All but one participant expressed their intention to continue use of their mHealth apps. The one exception intended to find a more user-friendly replacement for an app. Some participants added conditions such as:

[Interviewee #01] "as long as I need it"

[Interviewee #09] "Yes, for now yes. Unless, I find something else."

[Interviewee #11] "Till the new thing comes around"

These conditional statements may, in part, be a reflection of the novelty and fast-paced, changing nature of the mHealth app market, the voluntary nature of mHealth app adoption, the current state of low switching costs and the absence of a central guiding authority on the subject of mHealth apps.

4.9 Emergent Findings

Trust

Three out of four participants who used general health apps that measure medical parameters, i.e., heart rate and blood pressure, brought up trust as a factor for technology acceptance. One participant reported that his confidence in the reliability of the heart rate monitor that came pre-installed in his phone stemmed from the device manufacturer's assurance that the sensor on the specific type of smartphone functions in the same way as the sensor used in emergency rooms. A second participant expressed his former skepticism was supplanted by confidence after comparing pulse rate measured through his app with readings at his doctor's office.

[Interviewee #01] This one is really nice. It is integrated with the phone so. This program you cannot use in a different phone. You have to have this one actually has a special sensor that reads your blood heart rate. Exact same thing that they use in the ERs, similar kind of sensor.

[Interviewee #03] I was, you know, I didn't trust it. When I come now to the doctor, when I checked the app and the one she gave me, she check it, they are equal. I like it.

The third participant, a nurse by training, voiced her preference for a personal mobile medical device rather than her mHealth app to measure her blood pressure.

She believed the app to be inconsistent in its accuracy, perhaps due to its dependence on WiFi. She had noticed discrepancy between readings from the medical device and those from the app. Her suspicion is supported by a recent study that provided evidence for the inaccuracy of a popular blood pressure app [30].

[Interviewee #10] This is not accurate, no?

[Interviewee #10] Something it's same but sometimes there is a difference 5 points like that.

Privacy

Two participants reported privacy concerns due to the nature of information requested by the app such as a picture of the participant. Connectivity of mHealth apps with social media accounts can also be perceived as a threat to user's privacy, and therefore hinder app adoption.

[Interviewee #07] I didn't trust it. That's the thing. I felt like, even when they wanted a before and after picture, why do you need this? Who's gonna take this information? I just didn't trust the developers at all…like this big eye watching me.

[Interviewee #11] …I got frustrated with it is because it links to your Facebook and I don't like linking things to my Facebook.

5 Limitations and Future Research

mHealth apps are a relatively new phenomena and therefore, significant factors not included in the UTAUT2 model may not have been captured. From among the UTAUT2 concepts, price value and facilitating conditions could not be sufficiently assessed using data from this study. Individuals were required to be over the age of 18 to participate in the study; data for hedonic motivation may differ in the pediatric population. Furthermore, the types of mHealth apps were unrestricted and it may be argued that a more targeted evaluation of mHealth app adoption by category may yield a different set of observations. Although the flexibility of semi-structured interviews allowed for additional insights, the small sample size constrained information saturation. The results from this study, while not generalizable, may be transferable by informing future research in the area.

The following questions were generated from this study: Do users exhibit varying degrees of risk aversion depending on the type of mHealth app? Is higher education, particularly in the medical field, associated with greater hesitation to adopt mHealth apps? Is the demand for facilitating conditions subject to price of mHealth apps? Is hedonic motivation relevant to mHealth apps targeted towards pediatric populations? A multi-site, qualitative study with a larger sample size and a wider representation of the consumer population would likely result in improved information saturation which could be used to design a theoretical framework with significant explanatory power.

6 Conclusions

The results of this pilot study suggest that some UTAUT2 constructs may be more significant than others in the assessment of mHealth apps. Performance and effort expectancy were the most relevant concepts. mHealth apps that require longer interaction time are likely to be perceived as time sink. mHealth app developers should aim for enhanced app efficiency to lower the required user interaction time. Developers should also carefully consider the quality of information provided and feedback generated by mHealth apps. For example, managing performance expectation through in-app education/information may help prevent undue distress stemming from an app's feedback on health status. Visual, easily digestible feedback may also enhance user engagement and user empowerment.

Social influence and hedonic motivation were the least directly implicated concepts. Although social interactions may serve to introduce people to mHealth apps, the decision to promote ones personal health and wellness is primarily within ones personal domain and, therefore, social influence is less likely to impact change in mHealth app use. Bandura (1998) stated, "People do not behave like weathervanes, constantly shifting to whatever social influences happen to impinge on them at the moment. They adopt personal standards and regulate their behaviour by their self-sanctions. They do things that give them self-satisfaction and self-worth, and refrain from behaving in ways that breed self-dissatisfaction" [31]. It is also important to consider that hedonic motivation may be more relevant in the context of a sub-population of mHealth app users such as pediatric populations.

Other factors that may influence mHealth app adoption include trust and privacy. Evidence-based, guideline concordant and, where appropriate, regulated mHealth apps are best poised to address concerns of trust. Developers should also prioritize minimization of risks to users' privacy. Most users did not consider the integrity of the source of the mHealth apps making them vulnerable to potential harm. Evidence-based, guideline concordant mHealth apps would likely be better received for medical functions such as diagnostic, educational, or measurement apps (e.g. to measure heart rate), particularly among those individuals with higher education.

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