

## Research Article

# Use of Mobile Health Applications and the Self-Management of Chronic Disease

Rita Ma\*

Department of Human Services, Faculty of Welfare and Health Sciences, University of Haifa, Israel

### ABSTRACT

**Objectives:** Rising criticism regarding the effectiveness and risks associated with the growing use of *mobile health applications* necessitates an integrative approach to assess the effect of mobile health applications on self-management practices among individuals diagnosed with a chronic condition. We predict the likelihood of adopting (a) lifestyle and (b) healthcare self-management practices following the use of mobile health applications and controlling for variations in technology use, socioeconomic characteristics and personal health condition.

**Methods:** Using data released by Princeton (PEW) the study examines 1,492 individuals who use mobile health applications and 500 respondents (31.01%) diagnosed with a chronic condition.

**Results:** The findings from a secondary analysis indicate

that: First, age and a health crisis, along with parenthood, serve as basic attributes in predicting variations in the extent of technology use among individuals. Second, the effect of mobile health applications on self-management practices varies in terms of number and updating. Third, variations in personal health condition moderate the effect of mobile health applications.

**Conclusions:** We conclude that using mobile health applications is an important means in improving self-management practices among individuals diagnosed with a chronic disease but only to the extent that personal health conditions do not provide significant obstacle.

**Keywords:** Self-Management; Chronic disease; Mobile health applications; Personal health

### Introduction

Individuals diagnosed with a chronic disease must cope with various health-related functions on a daily basis to address their health-related concerns. Possessing the skills to use mobile devices can help in accessing relevant information on health concerns and health services [1]. Existing studies report that individuals with chronic disease use technology-based devices to search for more information consult online rankings or reviews engage in online health-related activity and exchange information with others who have similar health concerns. Yet, evidence concerning the use of *mobile health applications* (*Mapps*) among individuals diagnosed with a chronic disease is limited and mainly concentrates on specific groups and specific health-related uses. As a result, we lack empirical evidence linking *Mapps* use to *self-management* among individuals diagnosed with a chronic disease [2-4].

*Mapps* have become a common means for individuals in the general population to address their health needs and learn about health-related products and services on their own time and at their own pace [5]. In the United States (U.S.), *Mapps* are used by 21% of adults aged 18-24 [6]. Over two-thirds of European Union respondents (69%) think that faster and more reliable connection to digital sources would encourage them to make more use of recent digital technologies to increase wellbeing and address health concerns [7]. In the U.S. using and updating at least one type of *Mapps* is quite common among individuals seeking to adopt a “health-wise” lifestyle, increase their health

empowerment and increase the potential for effective health management [6,8-13].

Utilization of medical technologies indicates consumers' acceptance of health technology and helps individuals diagnosed with a chronic disease to better manage their chronic disease and attain their health goals. Yet, achieving these health goals for lifestyle or healthcare purposes is contingent upon the individual's ability to capitalize on technology-based resources available on the virtual space [14,15]. Recent studies, indeed, report gaps in the use of *Mapps* between individuals with no health concerns and individuals diagnosed with a chronic disease [16,17]. These gaps raise doubts about the effectiveness of “Web-based interventions” among individuals diagnosed with a chronic disease in adopting self-management behaviors [15,18-21]. In this study, we explore the factors associated with the impact of *Mapps* on self-management practices among individuals diagnosed with a chronic disease. We seek to determine the extent to which individuals diagnosed with a chronic disease use *Mapps* to address their needs for (a) lifestyle and (b) health tracking self-management practices.

*Mapps* enable an easy access to a wide range of health services in eating disorders alcohol use disorders [22,23]. *Mapps* have been found effective in encouraging physical activity, self-monitoring behaviors during weight loss, recording food intake during weight loss programs and providing support in psychotherapy [24-27]. A large proportion of mobile phone users have downloaded at least one health-related application

and more people use health-related sites than banking and other similar applications [5,28]. The vast majority of these applications were reported as "useful" and assessed as an important means of adopting new health habits [29-31].

Indeed, studies addressing the influence of Mapps indicate that individuals with a heart condition diabetes, cancer and other long-term conditions are willing to use Mapps to alleviate bothersome symptoms [16,32-36].

At the same time, health policymakers and scholars are still skeptical about the current evaluations regarding the effectiveness of Mapps, leading to raised concerns regarding the extent to which Mapps meet the specific needs of individuals diagnosed with a chronic disease [18]. Recent evidence indicates that Mapps use is moderated by personal health status and individuals diagnosed with a chronic disease report lower use of digital health services and are less likely to make effective use of self-management practices [2,17-21]. This evidence led health policymakers and practitioners to reconsider the usability of digital tools in affecting self-management practices and the need to reassess the clinical utility, benefits and risks of using Mapps in the context of prevention and management of disease among those diagnosed with a chronic disease [27,37,38]. The evidence also instigated further interest in public health and communication studies seeking to assess the effect of Mapps on self-management among individuals diagnosed with a chronic disease [39].

In the present study, we provide more information about this conflicting evidence. We assess how variations in Mapps use affect lifestyle and health-tracking self-management practices among individuals diagnosed with a chronic disease. We also consider how observed changes in their personal health status affect self-management practices controlling for the effects of Mapps.

## Background

The relevant literature addressing the use of technology makes two alternative and contradictory predictions. According to the *normalization hypothesis* the rise of the "information society" and adoption of the Internet have the capacity to reduce existing social inequalities. In affluent post-industrial societies, online information will gradually broaden over time, providing easy and cheap access to information and people [40]. Support for this hypothesis is evident in the growing use of mobile technology oriented to eHealth and m-Health sources for health purposes and the narrowing gaps in access to information and services [41].

By contrast, the *Social Diversification Hypothesis* refers to the differential use of such services according to people's socioeconomic background. This differential use may replicate and even amplify existing social inequalities. SDH implies that individuals characterized by limitations stemming from health, residential and social capital limitations will be less able to gain access to social services [41]. Here the role of Mapps can provide a catalyzing effect in reducing such limitations in health self-management [3,4].

## Use of Mapps among individuals diagnosed with a chronic disease

Human conditions generate "prerequisites" that can shape the opportunity to use technology. Such human conditions are primarily socioeconomic. Age, for example diminishes mobility and increases the likelihood that health must be monitored [42,43]. Similarly, gender is related to lower technology skills and differences in communication needs that may affect the degree women will be using Mapps [2,44].

In fact, according to the *Technology Acceptance Model* -(TAM) individuals differ in relation to their *perceived ease-of-use* and *perceived usefulness* of technology including Mapps. *Perceived ease-of-use* is the belief that technology can be used with little or no effort, especially in m-Health, e-Health and telemedicine research [45-49]. *Perceived usefulness* refers to the belief that the adopted technology helps individuals complete the task better. The existence of a chronic disease is often associated with a stronger need to perform daily routines, with the aim of lowering sources of dysfunction or feelings of disease [15]. Some studies have addressed the differences in needs and the role of technology for health purposes among patients diagnosed with cancer, heart conditions diabetes and other long-term conditions [16,33,35,36,50,51]. Similarly, gender and age differences may affect the willingness to use Mapps to access health services [2,12,41]. We hypothesize the following:

*H1: Socioeconomic variations will affect the extent to which people use Mapps.*

*H2: A chronic condition will affect the use of Mapps when socioeconomic variations are controlled.*

## Self-management of chronic disease

Individuals diagnosed with a chronic disease seek and use Mapps can maximize their involvement in health decisions and take concrete steps toward better health routines [52]. Nonetheless, information alone cannot guarantee that people will adopt healthy self-management behaviors [34,53]. Recent studies addressing the use of web-based interventions claim that digital sources and aids do not meet their intended purposes [17,18,54,55] because their "tailored" content limits possibilities of self-management practices. In fact, individuals diagnosed with a chronic disease report lower self-management practices [16,17,33]. Moreover, recent evidence among 2,802 participants indicates thought that even when individuals access extensively health sources to this extensive use wanes over time because individuals diagnosed with a chronic disease do not possess the necessary technological skills to update and increase their self-management potential using Mapps [56]. Differences in the way individuals diagnosed with a chronic disease use technology may affect their ability to capitalize on Mapps for improving self-management. Moreover, differences between self-management types may be of importance in defining the extent to which individuals diagnosed with a chronic disease adopt Mapps to promote self-management [57].

Indeed, the reasoned action approach assumes and later the integrative reasoned action approach suggest that individuals

diagnosed with a chronic disease need to recognize the difference between specific behaviors (e.g., walking for 20 minutes 3 times per week), behavioral categories (e.g., exercise, diet), and goals (e.g., lose weight) [58]. Their behavior involves an *action* directed at a *target* and performed in a given *context* at a certain point in *time*. It is therefore highly probable that individuals diagnosed with a chronic disease may adopt self-management behaviors that have different goals. This is why in the present study we distinguish between lifestyle and health track behaviors. Lifestyle behaviors include self-management practices that increase the likelihood to feel better through day-to-day routines, including exercise and better nutrition. Health track behaviors include behaviors that increase one's potential to monitor health concerns and detect early signs of health disturbances [15]. We contend that individuals diagnosed with a chronic disease will adopt "rational" behavior that will reflect the benefits associated with the probability of adopting such behavior [59]. We therefore hypothesize the following:

*H3a: Higher extent of Mapps use will increase the likelihood of lifestyle SM.*

*H3b: Higher extent of Mapps use will decrease the likelihood of health tracking SM.*

### Personal health status

The more recent studies of the Technology Acceptance Model (TAM) include additional explanatory variables to measure subjective norms and social influence [48]. These variables are of particular personal relevance among people who face certain conditions such as, specific health problem or disease [60]. Individuals diagnosed with a chronic disease are likely to use technology in different ways that fit their immediate and remote needs and perceptions of usefulness [57,61].

The term "affordances" plays a significant role here in unraveling the relationship between Mapps and SM. It describes the way individuals diagnosed with a chronic disease determine the extent to which Mapps will enable them to achieve action-based SM. The "affordance competition" hypothesis, suggests that a variety of affordances affect the degree to which actions are taken or not taken [62]. For example, the benefits of digital communication oriented toward receiving feedback and social support, and tracking were found ineffective for medication adherence and health care utilization [60]. This is especially important for individuals diagnosed with a chronic disease, for using Mapps may result in miscalculation or use of inadequate and possibly dangerous applications [33,63]. Similar differences were revealed among cancer patients those with heart conditions and additional types of chronic conditions [16,35,36,56,64]. As a result it is difficult to assess the effect of Mapps on self-management practices without considering the personal state of health of individuals diagnosed with a chronic disease [2,10,11,50]. We therefore hypothesize the following:

*H4a: Personal health status will affect the likelihood for lifestyle self-management behavior when extent of Mapps use is controlled.*

*H4b: Personal health status will affect the likelihood for health-*

*track self-management behavior when extent of Mapps use is controlled.*

## Methods and Materials

### Sample

This study draws on a secondary analysis of the data released by Princeton [6]. The sample comes from a national tracking survey of 8,323 individuals over the age of 18 contacted by landline and/or cellphone. The analysis is based on individuals who use Mapps (Mapps) (N=1,492). Five hundred respondents reported being diagnosed with a chronic disease (32.01%). The sample comprised 51.8% women and 49.2% men; 29.7% have less than a college degree; 60.6% are married or cohabitating; 41.4% are parents of children living at home; 24.2% earn less than \$30,000. A total of 1,192 individuals reported using a single health application (80%), while 300 reported using more than one (20%).

### Dependent variables

**Self-management:** (a) Lifestyle: Do you currently keep track of your own weight, diet, or exercise routine? (1=yes), (b) Health track: Do you track your own blood pressure, blood sugar, sleep patterns, headaches, or any other indicator? (1=yes).

### Independent variables

**Extent of Mapps use:** (a) *Number of applications used:* What kind of health apps do you currently have on your phone? Respondents replied to the question ten times for ten uses. We used the first four counts reporting four different types of health concerns (ranging from 1=single application to 4=four applications), (b) *Update frequency* (1= every day).

**Socioeconomic characteristics:** Age is a proxy for technology skills and likelihood of chronic illness (18 through 85 years old). Studies have shown that older individuals perform more poorly than do young people in using Internet browsers, finding search engines and navigating the Internet and as health usually deteriorates with age it is important to examine how age differences affect the use of Mapps [40,43]. *Gender is important as well* because consistent findings indicate that women use the internet for health purposes more than men do, and often reflect their social function as family caregivers (1=Male) [2,44]. *Marital status* was shown to signify the extent that married individuals who use online health services more frequently than single individuals to consult online rankings or reviews (1= yes) especially when they care for children [3,15]. This is why we examine *parental status:* Children under age of 18 (1= yes). Finally, *education* increases the likelihood of health literacy and ability to understand medical information, including drug prescriptions, the etiology of diseases and risks. Better cognitive skills attributed to highly educated individuals lead to better evaluation of health information [15]. Individuals with more education may have a greater desire to use technology for health related concerns than less educated individuals (1=no formal education through 10=PhD).

## Moderating effects

**Personal health condition:** (a) *Health crisis*: In the last 12 months, have you personally faced a serious medical emergency or crisis (1= yes), (b) *Health emergency*: In the last 12 months, have you personally gone to the emergency room or been hospitalized unexpectedly (1= yes). (c) *Health change*: In the last 12 months, have you personally experienced any significant change in your physical health, such as gaining or losing a lot of weight, becoming pregnant, or quitting smoking (1= yes).

## Results

### Predicting extent of use of Mapps among individuals diagnosed with a chronic disease

Examining the extent of technology use, we considered two aspects of Mapps use: the number of Mapps use and the updating frequency. Both aspects indicate the relevance of the parameters included in the Technology Acceptance Model (for individuals diagnosed with a chronic disease [48,60]). We run a series of regression tests and focus on the analysis of the regression coefficients. The coefficient B gives the size of the effect that variable is having on the dependent variable, and the sign on the coefficient (positive or negative) gives the direction of the effect. In regression with multiple independent variables, the coefficient tells us how much the dependent variable is expected to increase when that independent variable increases by one, holding all the other independent variables constant.

**Number of Mapps used:** Socioeconomic variables produce variations in the extent of Mapps use. Aging individuals with a chronic condition are less likely to use multiple applications. Being a man ( $B=0.381$ ) and having more education ( $B=0.031$ ) increase the number of mobile applications used. In contrast, parenting status decreases the likelihood of using multiple applications ( $B=-0.321$ ). A health crisis ( $B=-0.257$ ) has a minor negative effect as well.

**Updating frequency of Mapps:** Socioeconomic variables produce variations in the extent of Mapps updating. Frequency of updating is affected negatively by age ( $B=-0.018$ ) and parenthood ( $B=-0.388$ ). Moreover, the personal health status of individuals diagnosed with a chronic disease affects updating frequency. Emergency hospitalization ( $B=0.683$ ) and significant change in personal health condition ( $B=0.469$ ) both increase the likelihood of updating Mapps, indicating that individuals diagnosed with a chronic disease experiencing such situations are more likely to become aware of the usefulness of Mapps as a tool for health empowerment when controlling for the remaining socioeconomic effects described above. However, a health crisis decreases the likelihood of frequent updates ( $B=-0.409$ ), similar to the above effect of number of applications used. We conclude here that as indicated by the TAM model, the higher number of Mapps use, i.e. downloading more Mapps, is a basic step that is relatively easy to perform and reflects the perceived ease of use. Yet, updating multiple applications necessitates a more engaging attitude and indicates the degree of perceived usefulness as for example with certain applications such as blood pressure and weight loss. In both cases age and

a health crisis, along with parenthood, serve as basic attributes in addressing the extent of technology use among individuals diagnosed with a chronic disease.

### Predicting lifestyle and health track self-management among individuals diagnosed with a chronic disease

#### Socioeconomic effects

The findings in Table 1 indicate that socioeconomic effects significantly affect the likelihood for self-management, though the direction of the effects differ for lifestyle and health track SM. Lifestyle self-management is positively increased among older ( $B=0.008$ ), married ( $B=0.024$ ) and educated individuals diagnosed with a chronic disease ( $B=0.009$ ). However, being married ( $B=-0.43$ ), male ( $B=-0.093$ ) and having higher education ( $B=-0.012$ ) decrease the likelihood of experiencing health track self-management among individuals diagnosed with a chronic disease. The results indicate two important findings. First, we need to distinguish between lifestyle and health track self-management in order to reveal subtle differences in the antecedents affecting self-management behavior in individuals diagnosed with a chronic disease. Second, we need to control for socioeconomic variations before we assess the impact of technology effects. The results indicate that indeed, after socioeconomic variations are controlled, technology increases the likelihood of both lifestyle and health track self-management. More specifically, using ( $B=0.916$ ) and updating ( $B=1.624$ ) Mapps increase the likelihood for lifestyle self-management as well as for health tracking self-management ( $B=0.318$ ;  $B=1.673$ ). Clearly, Mapps affect self-management practices but even these effects can be minimized when personal health conditions emerge.

#### Personal health condition

The findings in Table 2 indicate that personal health condition affects self-management after controlling for the effect of Mapps. An emergency ( $B=0.205$ ), a crisis ( $B=0.397$ ) or a sudden change in one's condition ( $B=0.259$ ) all make an important contribution in explaining variations in self-management among individuals diagnosed with a chronic disease. The findings show that occurrence of a health crisis ( $B=-0.144$ ) or a health change ( $B=-0.139$ ) decreases the likelihood of lifestyle self-management. By contrast, occurrence of a health crisis ( $B=0.076$ ) or a health change ( $B=-0.052$ ) increases the likelihood of health track self-management. Clearly, the results indicate the effect of "affordances" related to personal health status among individuals diagnosed with a chronic disease using Mapps because they can moderate the effect of Mapps on self-management.

## Discussion

Individuals use Mapps for various health purposes in order to improve their health routines as well as increase their health empowerment. Among these uses are lifestyle behaviors such as stopping smoking, adhering to physical fitness programs and accessing health services, as well as health management behaviors such as sugar and blood pressure monitoring, cancer

**Table 1:** Regression coefficients (B) and explained variances predicting extent of use (quantity) and updating (frequency) of mobile health applications (Mapps) among individuals diagnosed with chronic disease.

	<i>Extent of use (number) of mobile health applications</i>						<i>Extent of updating (frequency) of mobile health applications</i>					
	B	S.E.	Wald	df	Sig.	Exp(B)	B	S.E.	Wald	df	Sig.	Exp(B)
<i>Age</i>	-0.063	0.004	316.499	1	0.000	0.939	-0.018	0.003	41.468	1	0.000	0.983
<i>Sex (1=men)</i>	0.381	0.100	14.466	1	0.000	1.463	0.032	0.087	0.133	1	0.715	1.032
<i>Married</i>	-0.027	0.025	1.165	1	0.280	0.974	0.088	0.021	18.043	1	0.000	1.092
<i>Parents (1=yes)</i>	-0.321	0.107	9.041	1	0.003	0.725	-0.388	0.100	15.103	1	0.000	0.679
<i>Education</i>	0.031	0.005	33.536	1	0.000	1.031	0.005	0.006	0.761	1	0.383	1.005
<i>Health emergency</i>	0.124	0.144	0.735	1	0.391	1.132	0.683	0.117	33.868	1	0.000	1.979
<i>Health crisis</i>	-0.257	0.135	3.650	1	0.056	0.773	-0.409	0.116	12.423	1	0.000	0.664
<i>Health change</i>	0.047	0.110	0.181	1	0.671	1.048	0.469	0.095	24.200	1	0.000	1.599
<i>Constant</i>	0.126	0.258	0.240	1	0.624	1.135	-1.441	0.227	40.316	1	0.000	0.237

**Table 2:** Regression coefficients (B) and Explained variances predicting SM (lifestyle) and SM (health track) following use and updating of mobile health applications (Mapps) among individuals diagnosed with chronic disease.

	<i>Lifestyle self-management</i>						<i>Health track self-management</i>					
	B	S.E.	Wald	df	Sig.	Exp(B)	B	S.E.	Wald	df	Sig.	Exp(B)
<i>Age</i>	0.008	0.002	28.282	1	0.000	1.008	0.016	0.002	104.435	1	0.000	1.016
<i>Sex (1=men)</i>	-0.034	0.050	0.465	1	0.495	0.966	-0.093	0.050	3.540	1	0.060	0.911
<i>Married</i>	0.024	0.012	3.654	1	0.056	1.024	-0.043	0.012	12.523	1	0.000	0.958
<i>Parents (1=yes)</i>	0.100	0.057	3.104	1	0.078	1.106	-0.038	0.056	0.462	1	0.497	0.962
<i>Education</i>	0.009	0.004	4.521	1	0.033	1.009	-0.012	0.004	11.750	1	0.001	0.988
<i>Application use</i>	0.916	0.121	57.397	1	0.000	2.500	0.318	0.106	9.035	1	0.003	1.375
<i>Application updating</i>	1.624	0.057	803.142	1	0.000	5.072	1.573	0.052	929.662	1	0.000	4.822
<i>Health emergency</i>	-0.045	0.078	0.327	1	0.567	0.956	0.205	0.076	7.200	1	0.007	1.227
<i>Health crisis</i>	-0.144	0.069	4.352	1	0.037	1.155	0.397	0.067	34.845	1	0.000	1.488
<i>Health change</i>	-0.139	0.063	4.933	1	0.026	1.149	0.259	0.062	17.750	1	0.000	1.296
<i>Constant</i>	-0.840	0.136	37.960	1	0.000	0.432	-1.323	0.135	95.969	1	0.000	0.266

and heart disease management and psychotherapy support. Yet existing studies supporting the beneficial effects of Mapps have focused mainly on the needs of specific health groups while neglecting the importance of comparing between differences in the use of Mapps and different types of self-management practices. Nevertheless, health institutions and professionals are aware of the lack of evidence linking variations in mobile health application use to differences in self-management behaviors. On the one hand, they report relying more and more on Mapps to increase health awareness and improve adherence to health management practices. At the same time, they are skeptical regarding the potential of Mapps to improve self-management practices.

In this study, we assessed the impact of variations in the use of Mapps on lifestyle and health-track management practices among individuals diagnosed with a chronic disease. Overall, the findings support the importance of Mapps in self-management practices, thus confirming the *normalization hypothesis* and the positive effect of technology in inducing better lifestyle and health practices [41]. The findings support the conclusions of recent studies [2,5,65]. Support for the study's findings is provided by the constantly rising percentage of mobile technology use oriented to e-Health and m-Health sources. Hence, we can conclude that Mapps play a significant role in reducing limitations upon self-management practices for

individuals diagnosed with a chronic condition [2,41,65-68].

Nonetheless, the results also point to important limitations regarding the effect of mobile health applications. First, assessing the effect of Mapps on self-management practices is difficult and possibly even inaccurate without examining the distinction between lifestyle and health management behaviors. Second, it is important to consider the individual's personal health status. A health crisis, a change in health condition and hospitalization can moderate the link between technology and self-management. As a result, while individuals with no personal health challenges find it easier to adopt self-management practices following the use of Mapps, for individuals with challenging personal health conditions the effect of Mapps is restricted. In some cases, personal health challenges may increase the likelihood of using Mapps and prompt adopting self-management practices, while in other cases these challenges may signify a need for careful consideration of Mapps use for health purposes. For the latter individuals, tailored Mapps are less appealing considering that they have specific needs or even face health risks [27]. This is especially important considering that variations in mobile health application use may affect self-management practices.

## Conclusion

These results have important implications for health-related

policy. The use of Mapps can easily enhance or disrupt the work of health professionals. The difference between lifestyle management and health-track management behaviors as detected in this study ultimately reflects not only the differential influence of technology use on self-management practices, but also and more importantly, the role of one's personal health situation in managing health concerns. This is especially important considering that health institutions and professionals are keener to rely more and more on the use of Mapps to increase health awareness and adherence to health management practices. We conclude that health policymakers and health practitioners should be encouraged to reconsider the usability of digital tools in affecting self-management practices among individuals diagnosed with a chronic disease. They should precisely assess the clinical utility, benefits and risks of using Mapps in the presence of unexpected health situations.

### Limitations and recommendations for future studies

The secondary level analysis of the study draws attention to the relatively limited number of items referring to the types of mobile applications use. Future studies should opt to consider how differences in mobile applications use contribute to self-management considering that some applications fit the needs of the chronically ill better.

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**ADDRESS OF CORRESPONDENCE:** Rita Mano, Department of Human Services, Faculty of Welfare and Health Sciences, University of Haifa, Israel, Tel: 9724249134; Mobile: 972547611608; E-mail: ritamano@research.haifa.ac.il

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