Motivation of Older Adults to Use Mobile Health Applications: A Self-Determination Theory Approach

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Abstract

Today's healthcare is becoming more and more digital. However, some factors make it harder for older adults to use technology, which leads to a digital divide. The digital divide refers to the gap or inequality between those who have access to and can effectively use technology, and those who lack such access and skills (Gunkel, 2003). Hence, it is crucial to tackle the digital divide for mobile health (mHealth) to guarantee equal access for all individuals, enabling them to fully embrace the advantages and opportunities presented by technology, such as improving and managing health remotely. The purpose of this study is to explore if motivation can increase mHealth application use among older adults. This is done by applying the self-determination theory (SDT), using the three psychological needs, autonomy, competence, and relatedness regarding intrinsic motivation. An online survey was conducted among 101 older mobile phone users of 65 years and older. The results showed that autonomy and relatedness were significantly associated with intrinsic motivation to use mHealth applications. Furthermore, autonomy was shown to be positively related to the use of mHealth applications by older adults. Findings suggest that the use of mHealth applications by older adults is enhanced when the applications are suitable, empowering older adults with a sense of personal control, and fulfilling their need for social connection, with a particular emphasis on the importance of adequacy and personal control when it comes to using mHealth applications. Thus, developing user-friendly mHealth applications for older adults, fostering control and social connections, can improve their usage.

Keywords: mHealth, older adults, SDT, intrinsic motivation, autonomy, competence, relatedness.

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The world is rapidly aging and with that, the workload in healthcare is becoming higher (Fuster, 2017). Today's healthcare services include the provision of digital tools, such as mobile health applications, to make these services more efficient and limit the strain on the healthcare system (Goel et al., 2013). Mobile healthcare systems are designed to enhance patient care in the hospital, at home, or remotely (Mansoor et al., 2015). Mobile health (mHealth) entails that health services and information can be obtained through mobile technology (Wang et al., 2021b). Mobile devices have become an essential tool in the digital healthcare industry, providing numerous benefits in healthcare processes due to their portability and ability to access information anytime and anywhere (Wang et al., 2021b). Mobile healthcare applications are crucial for the role of mobile devices in the medical field. These applications can be used for different forms of healthcare (e.g., regulating medicine intake, tracking sleeping patterns, and regulating chronic diseases like diabetes)

Changizi and Kaveh (2017) have shown that mHealth can improve care. They have proven that mHealth technology is effective for disease prevention and disease management and that mHealth is a suitable tool for older adults. Older adults (people of 65 years and older) tend to experience more health problems. Therefore, in reference to demographic aging, the number of patients that require healthcare has grown. For these older adults, however, many barriers may exist to go online for healthcare. For example, they might not be able to use a digital tool because of limited eyesight and/or hearing (Friemel, 2016). This leads to an important aspect that contributes to the use of digital technologies which is called the digital divide. The digital divide refers to the disparity between individuals, households, and communities that have access to and the ability to effectively use technology, particularly the Internet, and those that do not (Gunkel, 2003). For the present study, the use of technologies refers to if they have ever used an mHealth application or not. More specifically, the emphasis of the present study will be regarding the use of mHealth applications by older adults, also called the ‘grey divide’ (Morris & Brading, 2007).

According to Van Dijk (2003), there are not only ‘have-nots’ which entail that someone does not have access to digital tools, but also ‘want-nots’ which refer to the motivation aspect of the digital divide. Thus, the digital divide is not restricted to (not) having access to technology, but (lack of) motivation is also important. Motivation has been defined as a force that drives people to take action (Schiffman et al., 2010). Different types of motivation may lead to different cognitive, behavioral, and affective outcomes (Vallerand, 2001). Furthermore, personal preferences and motivations might be important in determining different types of engagement (Reisdorf & Groseli, 2017). One type of motivation is intrinsic motivation, which entails that the motivation lies in the behavior itself (Deci et al., 2017). This means that individuals are intrinsically motivated to perform tasks that provide them with a greater sense of enjoyment (Deci & Ryan, 1985).

It is important to understand how older adults think about and use (or avoid using) health-related technologies to be able to address the dimension of motivation of the digital divide and to ensure that older adults can fully participate in the increasingly technology-dependent world. Regarding the role of motivation within the digital divide, little is known about the role motivation plays in the use of healthcare-related technologies by older adults. The relationship between intrinsic motivation and mHealth application use is an important area of research that has implications for the design and implementation of mHealth interventions. By understanding the factors that influence intrinsic motivation, developers and healthcare providers can create mHealth applications that are more effective to get older adults to use these applications.

Research regarding the impact of intrinsic motivation on the use of mHealth applications by older adults has not been carried out yet. The current literature has focused on young adults' intrinsic motivation regarding mHealth application use but not on older adults specifically (e.g., Soni et al., 2021; Wang et al., 2021a). Furthermore, several studies have focused on older adults' motivation to use general communication technologies but not in the specific context of mHealth (e.g., Tyler et al., 2020). This means that there is currently insufficient knowledge about the relationship between older adults' intrinsic motivation to use mHealth application and their use of these applications. Therefore, this study aims to examine how intrinsic motivation contributes to the use or non-use of mHealth applications among older adults.

To better understand how intrinsic motivation is formed, the self-determination theory (SDT) can be implemented (Deci & Ryan, 1985, 1991, 2000). SDT is a theory from psychology that focuses on understanding psychological needs that drive human behavior and how they influence intrinsic motivation (Deci & Ryan, 2004). There are three psychological needs for intrinsic motivation according to SDT, autonomy, competence, and relatedness (Deci & Ryan, 2004). Autonomy refers to the need for individuals to feel in control of their lives and make decisions that are in alignment with their values and interests. In the context of this research, users of mHealth applications being able to make their own decisions to maintain their health management and set goals (Ryan & Deci, 2000). For older adults, this could mean being able to facilitate independent living (e.g., being able to self-monitor their diabetes and setting reminders for appointments) (Christiansen et al., 2020).

Furthermore, competence refers to the need for individuals to feel capable and effective in their actions and tasks (Ryan & Deci, 2000). In relation to the context of this research, older adults' users of mHealth applications feeling competent about their skills using an mHealth application to control their health behavior. In other words, being able to manage their health using mHealth applications. Relatedness refers to the need for individuals to feel connected to others and to experience a sense of belongingness (Ryan & Deci, 2000). When using mHealth applications, users can be more connected to their healthcare provider, which satisfies the user's need for relatedness (Ryan & Deci, 2000). For older adults, the need for relatedness provides a feeling of security. Christiansen et al. (2020) found that older adults described mHealth as a technical solution that helped them get in touch with someone if they needed help regarding their health.

Empirical studies have confirmed that each of these three psychological needs underlying intrinsic motivation by showing that whenever events affect the individual's experience of autonomy, competence, and relatedness, it leads to consistent changes in intrinsic motivational outcomes (Deci & Ryan, 1987; Grolnick et al., 1991; Vallerand & Reid, 1984). This study will explore these determinants of intrinsic motivation to use mHealth applications to answer the following research question:

RQ: To what extent do autonomy, competence, relatedness, and intrinsic motivation relate to the use of mobile health applications among older adults?

Theoretical Framework

Mobile Healthcare

Understanding the relationship between intrinsic motivation and the use of mHealth applications among older adults is important for the development of mHealth applications. mHealth is a part of digital health (Wang et al., 2021b). The term digital health is defined as "the cultural transformation of how disruptive technologies that provide digital and objective data accessible to both caregivers and patients leads to an equal level doctor-patient relationship with shared decision-making and the democratization of care" (Meskó et al., 2017). In comparison to traditional healthcare, digital healthcare provides many opportunities to facilitate prevention, early diagnosis of life-threatening diseases, and management of chronic conditions (Awad et al., 2021). Furthermore, digital devices allow patients to have more control and make better-informed decisions about their health (Awad et al., 2021). One of the primary advantages of mHealth care is the ability to provide healthcare services remotely. For example, it can be used to monitor health, share medical information, collect health data, access health records, make medical diagnoses, and prevent and manage diseases (Jembai et al., 2022). This is particularly beneficial for patients with chronic conditions who require frequent monitoring and management of their health. These patients can include older adults with for example diabetes, heart and vascular diseases, or dementia. Approximately one in four older adults have two or more chronic diseases and half of older adults have three or more chronic diseases (Matthew-Miach, 2016).

Digital Divide and Older Adults

Despite the numerous benefits of digital health technologies, there are still various factors that need to be considered regarding the use of digital health devices. One important factor is the digital divide. The digital divide has become more apparent in recent years due to the increasing reliance on technology for daily life activities, including healthcare. Therefore, it is important to address this digital divide for mHealth to ensure that everyone wants to use mHealth applications to take advantage of the benefits and opportunities that technology provides. More specifically, address the ‘want-nots’ aspect of the digital divide (Van Dijk, 2003). In other words, explore the motivational role to use mHealth, to bridge the digital divide. Motivation in health is focused on achieving specific goals, which can encourage people to engage in healthy behaviors. It has been found that motivation toward health is a significant factor in predicting individuals’ engagement in preventive health behaviors, acquiring health information, and maintaining good health (Moorman & Matulich, 1993).

Accordingly, understanding how older adults are motivated to use (or avoid using) mHealth applications is important to address the digital divide. More specifically understand how older adults are intrinsically motivated to use mHealth applications to engage in health management. According to Tyler et al. (2020), intrinsic motivation is the most important when increasing technological skills and digital literacy for older adults. Older adults need to have self-efficacious and socially connected experiences with varied technologies that demonstrate how the technology can address their personally valued social, instrumental, and informational needs to use technology (Tyler et al., 2020).

Self-Determination Theory

To understand older adult users' intrinsic motivation in the context of mHealth applications, SDT by Deci and Ryan (1985) can be used. SDT has been applied in a wide range of areas, including healthcare. In health, SDT suggests that supporting individuals' autonomy and competence can lead to greater adherence to healthy behaviors via intrinsic motivation (Williams, 2002). Additionally, SDT posits that the three psychological needs, autonomy, competence, and relatedness, are related to intrinsic motivation (Deci & Ryan, 1985). Wang et al. (2021a) showed in their study among mHealth users of all ages that users' autonomy, competence, and relatedness positively promote their intrinsic motivation for using all kinds of mHealth applications. Soni et al. (2021) have established a positive relationship between psychological needs and intrinsic motivation regarding the engagement of mHealth applications by young consumers. On that account, the present study tends to find out if that positive relationship is also present in older consumers. To explain how these concepts are related to intrinsic motivation and therefore to mHealth application use by older adults, it is necessary to take a closer look at the three needs.

Firstly, autonomy refers to an individual's sense of choice and self-direction (Deci & Ryan, 1987). An autonomy-supportive environment provides individuals with a sense of choice and control over their actions and decisions, which can lead to increased intrinsic motivation (Deci & Ryan, 1987). Deci and Ryan (1987) argue that when individuals feel a sense of autonomy, they are more likely to experience intrinsic motivation because they feel that their actions are aligned with their values and interests. In the context of this research, autonomy refers to having a sense of choice and control over their health behavior by using mHealth applications. Therefore, if an mHealth application provides a sense of control and enjoyment to determine their health management goals, satisfying the need for autonomy, it can intrinsically motivate the user to utilize the application (Wang et al., 2021a). This proposes that autonomy is positively related to intrinsic motivation to use mHealth applications, which leads to the following hypothesis:

H1: A higher sense of autonomy in older adults is associated with higher levels of intrinsic motivation to use mHealth applications.

Additionally, the psychological need for competence might also influence intrinsic motivation. Competence involves having opportunities to exercise and express one's skills and abilities (Deci & Ryan, 2004). The need for competence leads people to seek challenges that align with their capacities (Deci &Ryan, 2004). In the context of this research, competence refers to being capable and feeling effective in health management tasks via mHealth applications. It is a sense of confidence and effectiveness in action (Deci & Ryan, 2004). Soni et al. (2021) have found a positive correlation between competence and intrinsic motivation to use mHealth applications among college students. The current study tends to find out if the same positive correlation holds for older adults. Additionally, Vallerand and Reid (1984) have also found that competence had a positive effect on intrinsic motivation, suggesting that individuals who perceive themselves as competent in a task are more likely to be motivated to engage in that task. This proposes that competence is positively related to intrinsic motivation. Therefore, the following hypothesis can be made:

H2: A higher sense of competence in older adults is associated with higher levels of intrinsic motivation to use mHealth applications.

Furthermore, the psychological need for relatedness is related to intrinsic motivation. Relatedness refers to a sense of connection and belongingness that individuals feel with other individuals, such as family members, friends, and peers (Deci & Ryan, 2004). It refers to the need to feel oneself as being in relation to others (Deci & Ryan, 2004). Grolnick et al. (1991) show that relatedness and intrinsic motivation are closely linked, as individuals who feel connected and supported by others are more likely to be motivated to pursue their goals and interests. For example, Grolnick et al., 1991 have found that children who felt connected to their peers were more likely to be intrinsically motivated to participate in classroom activities. In relation to this context, users who want to encounter friending, commenting, and sharing experiences, which can be utilized by the health community in mHealth applications, are more intrinsically motivated to participate in using mHealth applications (Wang et al., 2021a). This study aims to find out if relatedness is also positively related to intrinsic motivation in the context of older adults and therefore proposes the following hypothesis:

H3: A higher sense of relatedness in older adults is related to higher levels of intrinsic motivation to use mHealth applications.

According to Deci and Ryan (2004), these needs are the basis for human motivation and drive behavior. In the context of mHealth, these needs can be satisfied when individuals perceive that using mHealth applications supports their own health goals and preferences (autonomy), allows them to effectively manage their health conditions (competence), and enables them to connect with others who share similar health concerns (relatedness). When individuals feel that their needs are being met, they are more likely to experience intrinsic motivation, which refers to doing something for the inherent enjoyment and satisfaction it brings (Ryan & Deci, 2000), to use mHealth applications for health management. SDT emphasizes that intrinsic motivation to use mHealth applications is essential for long-term satisfaction and well-being, as it involves engaging in activities for their own sake, rather than for external rewards. There are several broader studies regarding motivation and use. For example, Tyler et al. (2020) have found that motivation centered around personal value matters the most when it comes to the use of information communication technologies. Therefore, it could be expected that intrinsic motivation is an important determinant for the use of mHealth applications. Furthermore, Ryan and Deci (2004) state that intrinsic motivation increases the frequency of behavior. Accordingly, it can increase the use of mHealth applications. This proposes that individuals who are intrinsically motivated will show more use of mHealth applications. The following hypotheses can be made:

H4a: A higher sense of autonomy is positively related to mHealth application use.

H4b: A higher sense of competence is positively related to mHealth application use.

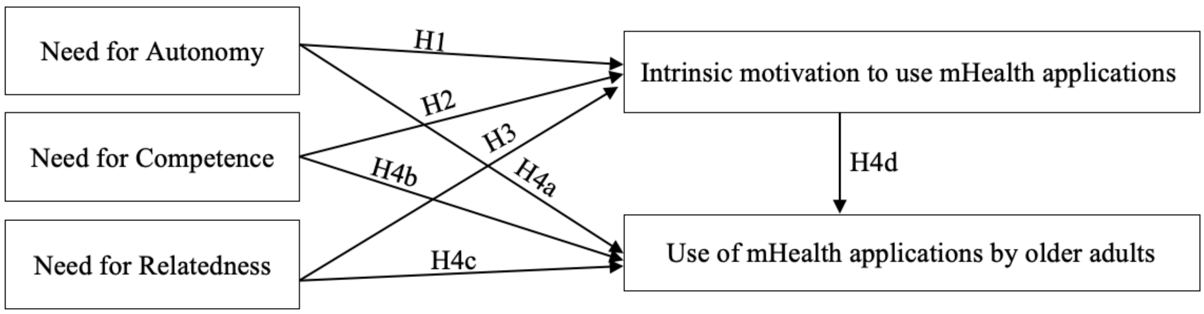
H4c: A higher sense of relatedness is positively related to mHealth application use.

H4d: Higher levels of intrinsic motivation to use mHealth applications are positively related to mHealth application use.

Following these hypotheses, a model is proposed (see Figure 1) to test the factors affecting the use of mHealth apps by older adults.

Figure 1

Proposed model



Method

Instruments

To be able to answer the study's research question, a survey was conducted among people of 65 years and older, measuring if the three psychological needs, autonomy, competence, and relatedness, and intrinsic motivation are related to the use of mHealth applications. In other words, if the use of mHealth applications by older adults increases when the psychological needs are met and when the intrinsic motivation is high. A survey was the most suitable for this study because a survey helps to explain why some phenomena work in a specific way (Moser & Kalton, 2017). In this context, explaining how mHealth application use among older adults works regarding the psychological needs and intrinsic motivation. Additionally, a survey was able to analyze the correlation of one factor (intrinsic motivation) and another (use). This method was more suitable than interviews because interviews are for in-depth research and focus more on the 'why' rather than the 'how'. This study focusses on the 'how' by investigating how the psychological needs and intrinsic motivation relate to the use of mHealth applications. The survey that was used can be found in Appendix A.

Respondents

An a priori power analysis was conducted using G*Power version 3.1.9.6 (Faul et al., 2007) to determine the minimum sample size required to test the study hypothesis. Results indicated that the required sample size to achieve 80% power for detecting a medium effect (0.3) (Clever, et al.1997), at a significance criterion of $\alpha = .05$, was $N = 23$ for a correlation analysis between two variables in the model. There were in total four determinants for the use of mHealth applications (autonomy, competence, relatedness, and intrinsic motivation). Thus, the present study needed four times the calculated sample size $N = 92$. The target group of this study was older adults (people of 65 years and older). Therefore, this study needed a minimum of 92 people of 65 years and older to adequately test the study hypothesis.

In total, 159 people filled out the survey, of which 107 completed the survey. The eligible subsample, that is those who were 65 years and older and had ever used a smart device, consisted of 102 older adults. Respondents needed to have used a smart device because this means they had experience and knowledge of mobile applications. Of those respondents, one seemed to be a straightliner. This means that the respondent had the same answer for every scale question. Therefore, this respondent was excluded from the dataset, resulting in a final sample of 101 older adults. 49.5% of the respondents belonged to the age group of 65-70 years old, 27.7% belonged to the 71-75 age group, 13.9% belonged to the 76-80 age group, 5.9% belonged to the 81-85 age group and 3.0% belonged to the 86+ group. Of all respondents, 59.4% were female and 40.6% were male. Most of the respondents lived with their partner (75.2%), 22.8% lived alone and 1% lived with (grand)children. Most respondents owned a smartphone (99%), followed by a tablet (79.2%), and a third of the respondents also owned a wearable (32.7%).

Procedure

Respondents were asked to take part in an online survey. The respondents were recruited via personal contacts. Additionally, the survey was spread on Facebook, LinkedIn, and Instagram. The survey contained an introduction explaining the procedure of the study and a demographic section to collect background information on clients. After that, an explanation of mHealth applications was given, to which questions regarding the use of smart devices (i.e., smartphone, tablet, wearable) were added. Individuals who had never used a smartphone or tablet were screened out before questions about mobile health app use, psychological needs (i.e., autonomy, competence, relatedness), and intrinsic motivation were introduced. The survey ended with questions about the frequency of use of mHealth applications that the respondents had installed on their smart device(s). On average, respondents took 12 minutes to complete the survey.

Measures

Psychological Needs

To assess the psychological needs, a 12-item measure was used. Several items were sourced from different studies and other items were originally created by using the definition of the different psychological needs. The first two items for autonomy were taken from Sheldon et al. (2001), which were translated into Dutch, and “during this event” was replaced with “using an mHealth app”. The other two items were originally created for this study, which resulted in four items in total to measure autonomy (4 items, e.g., “I feel free to use a mHealth app in my own way”). The items for competence were drawn from Sheldon et al. (2001) and McAuley et al. (1989). The items were translated into Dutch and “using mHealth apps” was added (4 items, e.g., “I am able to successfully use a mHealth app”). The items for relatedness were sourced from Sheldon et al. (2001) and Lee (2015). These items were translated into Dutch and “during this event” and “Qboard” were replaced with “mHealth apps” (4 items, e.g., “When people around me use mHealth apps, I am more likely to use it"). Items were rated on a 7-point Likert scale, ranging from 1 (*Completely disagree*) to 7 (*Completely agree*). Therefore, a higher score on the Likert scale means a higher need for autonomy, competence, or relatedness.

To test if the scales measured the three different constructs (autonomy, competence, and relatedness), a factor analysis was conducted. After that, the Cronbach’s alpha was calculated based on the results of the factor analysis. The factor analysis showed that Bartlett’s test is significant χ^2 (66) = 630.15, $p < .001$, indicating that the psychological needs in the dataset are indeed related. Moreover, with a value of .74, KMO’s measure for sampling adequacy is well above the 0.50 minimum value, which means that a substantial proportion of the variance can be accounted for by the factors. The factor structure of 12 different items (autonomy, competence, and relatedness) measuring psychological needs was assessed by performing a Principal Component Analysis with a Varimax Rotation. The analysis revealed that four factors together explained 76.3% of the variance ($EV_{factor1}$ = 3.90, $EV_{factor2}$ = 3.03, $EV_{factor3}$ = 1.23, $EV_{factor4}$ = 1.01). The items of competence loaded on one factor (4 items, α = .89), as well as relatedness (4 items, α = .85). The items of autonomy, however, loaded on two factors. Combining the four autonomy items into one scale led to an unreliable scale (4 items, α = .56). It was therefore decided to split autonomy into two subscales. The first subdimension of autonomy (2 items, α = .72) which contained the items "I feel free to use an mHealth application in my own way" and "I feel that the choice to use an mHealth application is based on my own values and interests". Followed by the second subdimension of autonomy (2 items, α = .76) which contained the items "I feel that the use of mHealth applications suits me" and "I feel that I am in control about my health when I am using an mHealth application".

Intrinsic Motivation

The construct that was used to measure the determinants of intrinsic motivation were designed using existing scales. The construct was borrowed from prior literature and modified to suit the context of the current study. To measure intrinsic motivations, items were taken from Attig and Franke (2019), who adapted these items based on SDT by Deci and Ryan (1985). Three items were used to measure intrinsic motivation (e.g., "I find it interesting to deal with my health data via mHealth apps"). These items were rated on a 7-point Likert scale, ranging from 1 (*Completely disagree*) to 7 (*Completely agree*). On this scale, a higher value meant higher intrinsic motivation. The reliability of intrinsic motivation comprising four items was good: α = .92. Consequently, the mean of all four items was used to calculate the compound variable intrinsic motivation, which was used in further analyses.

mHealth App Use

The use of mHealth applications referred to if they have ever used a mHealth application. The questions used by Bol et al. (2018) were used and adapted to the current study to measure mHealth app use. The questions from Bol et al. (2018), regarding the number of apps on the smart devices were reduced to a maximum of five instead of 15. This was done because a pre-test among 5 older adults had shown that they did not have more than five mHealth apps on their smart devices. Respondents were asked to take their smart device(s) and report which health apps they had installed on their device(s), with a maximum of five apps. After that, respondents were asked to indicate how often they used each of these mHealth apps. They were given eight options ranging from “almost every day” to “never”. Respondents who had filled in that they had installed one or more mHealth applications on their smart device and indicated that they used these mHealth applications were coded as users. The respondents who had respondent “never” at every mHealth app they had filled in, were recoded as non-users. A distinction between users from non-users was made, with the non-users’ group as the reference category.

Statistical Analysis

The independent variables of the first three hypotheses were need for autonomy, need for competence, need for relatedness and the dependent variable was intrinsic motivation. Intrinsic motivation was measured on an ordinal scale. To be able to test the effect of psychological needs on intrinsic motivation a multiple regression analysis was conducted. In the last hypotheses, the independent variables were need for autonomy, need for competence, need for relatedness, and intrinsic motivation and the dependent variable was use of mHealth applications by older adults. Use of mHealth applications by older adults had a binary outcome. Therefore, a logistic regression analysis was conducted to establish the effects of psychological needs and intrinsic motivation on the use of mHealth applications by older adults. All independent variables were entered into the model as continuous variables.

All demographics (age, gender, and living situation) were added in the second block of the logistic regression analysis to test if the different demographics had any effect on the use of mHealth applications by older adults. Gender was entered into the model as a dichotomous factor, with the male group as the reference category. Furthermore, the demographic variable living situation was also entered into the model as a dichotomous factor as either living alone or not alone. This has been done because only 1% lived of the respondents lived with their (grand)children and the rest all lived with either their partner (not alone) or alone. The demographic age was a categorical variable. A coding method should be applied when using categorical variables in a logistic regression analysis since a logistic regression analysis requires that all variables are continuous variables (Alkharusi, 2012). For the demographics age a dummy coding method will be applied. This method uses values 0 and 1 to represent group membership. Specifically, membership in a particular group is coded 1 and non-membership is coded 0. The reference group only receives 0s on all dummy variables (Cohen & Cohen, 1983; Myers & Well, 2003). There are five age groups which means four dummies will be created and the group of 86+ years was used as a reference group.

The results of the multiple regression analysis are presented with beta values. These values are the average amount by which the dependent variable, in this case intrinsic motivation to use mHealth applications, increases when the independent variable increases. For the logistic regression, the outcomes are presented in the form of odds ratios. A value greater than 1 implies a higher probability of using mHealth applications (e.g., an odds ratio of 2 indicates that this group is twice as likely to use mHealth applications than the non-users). On the other hand, a value less than 1 implies a lower likelihood of mobile health app usage (e.g., an odds ratio of 0.5 suggests that this group is half as likely to use mHealth applications than the non-users).

For both analyses, the assumptions were met, which means that the regression model from the sample is likely the same as the population model. It does not mean that they are the same but the likelihood of them being the same is increased. An elaborate description of the procedure and results of assumption checking can be found in Appendix B.

Results

mHealth Application User and Non-user Descriptives

Of the 101 respondents that filled in the questionnaire, 65 respondents (64.4%) indicated that they had at least one mHealth application installed on their smart device versus 36 (35.6%) who had not installed a mHealth application on their smart device. Of those who reported having mHealth applications, 61 (60.4% of the total sample) actually used their mHealth application; thus 4 (3.97% of the total sample) individuals indicated that they had mHealth applications installed but never used them. Therefore, the division between users and non-users was as follows, 61 (60.40%) users and 40 (39.60%) non-users. The older adults who reported having mHealth applications had three mHealth applications on their smart device on average ($M = 2.92$, $SD = 2.06$).

Explaining Relationships Between Psychological Needs and Intrinsic Motivation

A multiple regression analysis showed that the four variables entered, the first subdimension of autonomy, the second subdimension of autonomy, competence, and relatedness, explained 49% of the variance in intrinsic motivation, F (4, 96) = 24.43, $p < .001$. The second subdimension of autonomy was shown to be a significant predictor of the use of mHealth applications ($\beta = .58$, $p < .001$). Intrinsic motivation could increase when older adults reported to experience more control and feel that the mHealth application suits their identity. This is in line with the hypothesis (H1) that a higher sense of autonomy in older adults is associated with higher levels of intrinsic motivation to use mHealth applications, which means that H1 was partially supported. Furthermore, relatedness was shown to be a significant predictor of the use of mHealth applications (β = .21, p = .014). Intrinsic motivation could increase when older adults have a greater sense of belonging when using mHealth applications, which is also in line with the hypothesis (H3) that a higher sense of relatedness in older adults is associated with higher levels of intrinsic motivation to use mHealth applications.

However, the first subdimension of autonomy was not a significant predictor (β = .00, p = .958). This means that the freedom of using an app in your own way and according to your interests does not significantly influence intrinsic motivation. This is not in line with the hypothesis (H1) that a higher sense of autonomy in older adults is associated with higher levels of intrinsic motivation to use mHealth applications. Therefore, H1 was partially rejected. Additionally, competence was not a significant predictor (β = .04, p = .631). Therefore, being capable to effectively use an mHealth application does not significantly influence intrinsic motivation, which is not in line with the hypothesis (H2) that a higher sense of competence in older adults is associated with higher levels of intrinsic motivation to use mHealth applications. In Table 1, the outcomes of the multiple regression analysis are presented. Furthermore, in Figure 2, the results regarding H1, H2, and H3 are visualized.

Table 1

Regression analysis for autonomy, competence, and relatedness as predictors of intrinsic motivation to use mHealth applications (N = 101)

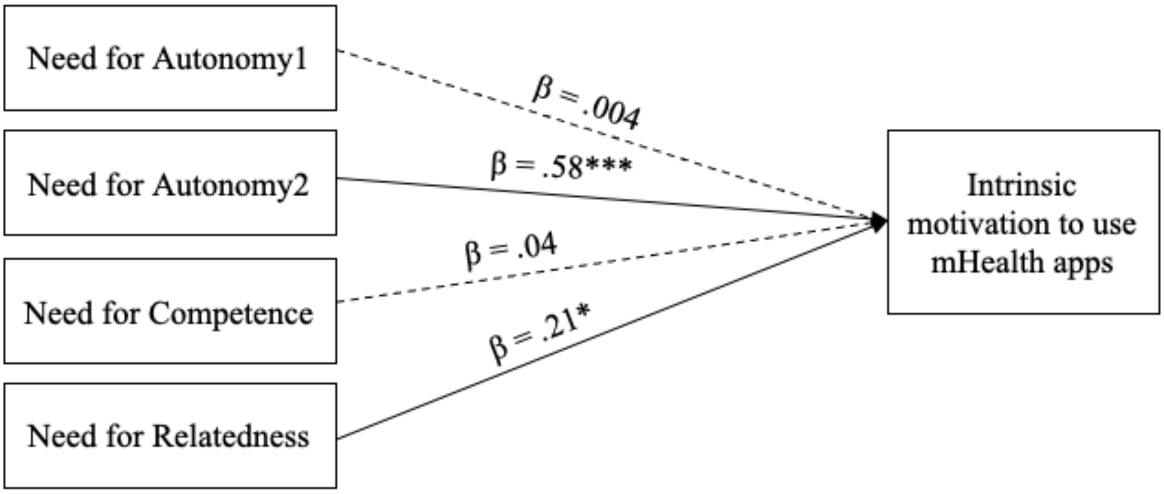
Variable	*B*	*SE B*	β	Fit
Autonomy1	.005	.090	.004	
Autonomy2	.656	.095	.580***	

Competence	.042	.087	.039	
Relatedness	.231	.092	.205*	
R^2				$R^2 = .49$

Note. * $p < .05$, ** $p < .01$, *** $p < .001$. Autonomy1 refers to the first subdimension of autonomy and autonomy2 refers to the second subdimension of autonomy.

Figure 2

Visualization of the multiple regression analysis



Note. * $p < .05$, ** $p < .01$, *** $p < .001$. Dashed lines represent non-significant relations with intrinsic motivation to use mHealth applications.

Explaining Predictors of mHealth Application Use of Older Adults

A logistic regression analysis was performed to ascertain the effects of the first subdimension of autonomy, the second subdimension of autonomy, competence, relatedness, and intrinsic motivation on mHealth application use by older adults. The model explained 21% (Nagelkerke R^2) of the variance in mHealth application use. The logistic regression analysis showed that only the second subdimension of autonomy was significantly associated with mHealth application use (OR = 1.50; 95% CI 1.02-2.21). This means that older adults who reported to feel control when using the mHealth application and it suits their identity were 1.5 times more likely to use a mHealth application. No significant differences were found between users and non-users for the first subdimension of autonomy (OR = 0.91; 95% CI 0.67-1.23), competence (OR = 1.21; 95% CI 0.91-1.61), relatedness (OR = 1.02; 95% CI 0.74-1.42), and intrinsic motivation (OR = 1.09; 95% CI 0.78-1.52). Accordingly, H4a was partially supported. However, the other hypotheses regarding mHealth use by older adults (H4a (partly), H4b, H4c, and H4d) were rejected.

Additionally, the demographics were added into the logistic regression to test the effects of age, gender, and living situation on mHealth application use by older adults. The model explained 30% (Nagelkerke R^2) of the variance in mHealth application use. The logistic regression analysis showed that there were no significant differences found between users and non-users for age (OR = 0.72; 95% CI 0.05-10.49) (OR = 0.69; 95% CI 0.05-10.46) (OR = 0.55; 95% CI 0.03-9.49) (OR = 0.00; 95% CI 0.00- 0.00), gender (OR = 1.45; 95% CI 0.56-3.79) and living situation (OR = 1.67; 95% CI 0.47-5.96). In Table 2, the outcomes of the logistic regression analysis are displayed, both unadjusted and adjusted for demographic outcomes. Furthermore, Figure 3 visualizes the results regarding the logistic regression of all independent variables on mHealth application use.

Table 2

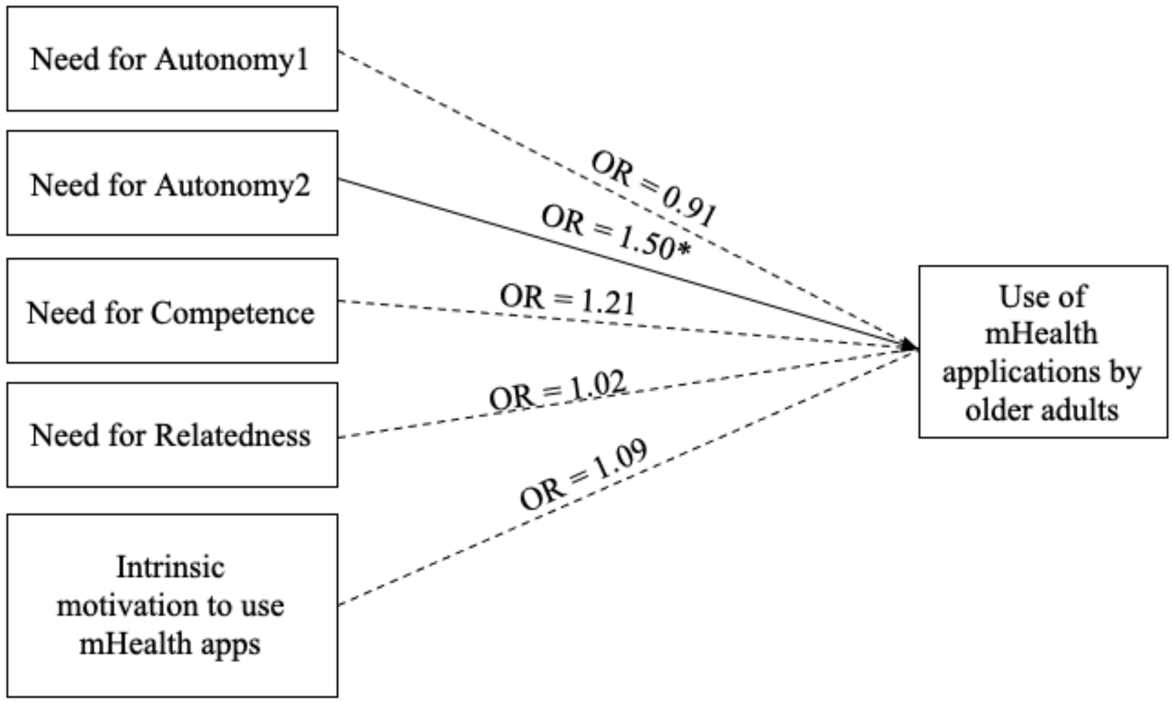
Logistic regression model explaining mHealth application use (N =101)

	Unadjusted[a]		Adjusted for demographic variables[b]	
Variable	*OR*	95% CI	*OR*	95% CI
Autonomy1	0.91	[0.67, 1.23]	0.95	[0.69, 1.30]
Autonomy2	1.50*	[1.02, 2.21]	1.47*	[0.94, 2.29]
Competence	1.21	[0.91, 1.61]	1.10	[0.81, 1.49]
Relatedness	1.02	[0.74, 1.42]	0.99	[0.70, 1.30]
Intrinsic motivation	1.09	[0.78, 1.52]	1.11	[0.76, 1.61]
Age (1)			0.72	[0.05, 10.49]
Age (2)			0.69	[0.05, 10.46]
Age (3)			0.55	[0.03, 9.49]
Age (4)			0.00	[0.00, .]
Gender			1.45	[0.56, 3.79]
Living situation			0.60	[0.17, 2.13]

Note. * $p < .05$, ** $p < .01$, *** $p < .001$. Autonomy1 refers to the first subdimension of autonomy and autonomy2 refers to the second subdimension of autonomy. [a]Five variables related to psychological needs and intrinsic motivation entered simultaneously. [b]Effects of psychological needs and intrinsic motivation on mHealth application use adjusted for age, gender, and living situation.

Figure 3

Visualization of the findings of the logistic regression analysis



Note. * $p < .05$, ** $p < .01$, *** $p < .001$. Dashed lines represent non-significant relations with mHealth application use.

Discussion

The aim of this study was to investigate the relationships between psychological needs, intrinsic motivation to use mHealth, and the use of mHealth applications by older adults. These relationships were studied through a self-determination theory approach (Deci & Ryan, 1985, 1991, 2000). SDT was used to understand older adults' intrinsic motivation by the psychological needs – that is, autonomy, relatedness, and competence – that drive human behavior (Deci & Ryan, 2004). Understanding how older adults think about and engage with mHealth applications is crucial for addressing the digital divide and ensuring their full participation in an increasingly technology-dependent world. However, there is insufficient knowledge about the connection between the psychological needs, intrinsic motivation, and the use or non-use of mHealth applications by older adults. Therefore, the findings of this study can provide valuable insights for developers of mHealth applications and healthcare providers, enabling them to create more effective and engaging apps tailored to the needs and motivations of older adults. To get insights into the relationship between psychological needs and intrinsic motivation for mHealth application use, an online survey was conducted among 101 older adults.

A first notable finding is that descriptive statistics showed that many (64.4%) of the older adults in the sample had at least one mHealth application installed on their smart device, and 60.4% of the total sample were actual users of the mHealth applications. These findings suggest that mHealth applications are relatively popular among the surveyed population, with a substantial number of individuals actively engaging with them. This is in contrast with the literature that has consistently shown that older adults can have many barriers to going online for healthcare. For example, having limited eyesight and hearing (Friemel, 2016). These factors lead to a division between people who have access to and are able to use technology and people who do not, previously explained as the digital divide (Gunkel, 2003). Older adults tend to be the biggest group who belong to people with no access to or are unable to use technology, also known as the 'grey divide' (Morris & Brading, 2007).

The fact that a lot of older adults in this sample reported to have mHealth applications and use them could be explained by several reasons. Today's technology has already been made more accessible and user-friendly for older adults (Darroch et al., 2005; Hourcade & Berkel, 2008). For instance, mobile phones have a function to increase the font size and icon dimensions, which makes it easier for older adults with visual impairments to read and navigate (Darroch et al., 2005; Hourcade & Berkel, 2008). Nevertheless, these improvements are only a small part of bridging the digital divide. These enhancements help older adults have easier access to mHealth applications (first level divide) and be able to use them (second level divide) (Scheerder et al., 2017; Van Deursen & Van Dijk, 2014). However, it does not cover the "digital usage gap", also referred to as the third level divide (Scheerder et al., 2017; Van Deursen & Van Dijk, 2014). There is still space for development regarding mHealth within the context of addressing the third level divide. The present study helped to find notions on which the third level divide can be minimized by looking at factors that can influence the use of mHealth applications by older adults.

Relationships Between Psychological Needs and Intrinsic Motivation

Another major finding was that the need for autonomy (partly) and relatedness played an important role in older adults' intrinsic motivation to use mHealth applications. This means that a higher need for autonomy, specifically having a higher need for personal control and mHealth applications to be suitable, and relatedness (i.e., having a sense of connection and belongingness with other individuals) were found to positively relate with intrinsic motivation to use mHealth applications. Therefore, these results suggest that mHealth applications that offer a sense of control and connection to others can fulfil older adults' psychological needs and may be an important reason for older adults to want to use mHealth applications. This result is in line with the study by Wang et al. (2021a), who explained that if an mHealth application enables users to experience a sense of control and enjoyment when setting their health management goals, thereby fulfilling their need for autonomy, it has the potential to intrinsically motivate them to use the application. Additionally, these results correspond with Grolnick et al. (1991) who showed that relatedness and intrinsic motivation are closely connected, as individuals who experience a sense of belongingness and support from others are more likely to be motivated to pursue their goals and interests. Furthermore, it is also in line with the broader theoretical assumption of the SDT that explains that these psychological needs form the foundation of human motivation and influence behavioral patterns (Deci and Ryan, 2004).

Although the previous part is in line with the literature, the findings that partly autonomy and competence do not influence intrinsic motivation to use mHealth applications are not in line with the existing literature. The first subdimension of autonomy is not related to intrinsic motivation to use mHealth applications. Therefore, older adults who have the freedom to utilize an mHealth application according to their own preferences and values, allowing them to personalize their usage experience are not intrinsically more motivated to use mHealth applications, even though Deci and Ryan (1987) argued that when individuals feel that their actions are aligned with their values and interests, they are more likely to experience intrinsic motivation. This means that regarding the need for autonomy, a suitable mHealth application and having a sense of control are more important factors to encounter intrinsic motivation than users' personal values and interests and using the mHealth app in one's own way. An explanation for this could be that values and interests and using an mHealth application in a unique manner are not very important among older adults. In contrast, older adults might value clear guidance and structure in utilizing mHealth applications, as it can provide a sense of control and effectiveness in managing their health (Harrington et al., 2017). Therefore, focusing on the second subdimension of autonomy, suitable functionality, and control, provides a more standardized approach that can be relevant and effective for a broader range of older adults.

Additionally, Vallerand and Reid (1984) suggested that individuals who perceived themselves as competent in a task are more likely to be motivated to engage in that task. That would mean that competence has a positive effect on intrinsic motivation. However, the present study has not found a positive effect regarding competence and intrinsic motivation. This could be explained with the socio-emotional selective theory (Carstensen, 1987, 1991). This theory describes how individuals' behavior in relation to their perceived time left in life (Carstensen et al., 2003; Fung et al., 2001; Fung & Carstensen, 2004). The emotional needs rise in old age when future-oriented strivings are less relevant (Carstensen et al., 2003). Furthermore, when people realize they are approaching the end of life, they care more about experiencing meaningful social relations and less about expanding their horizons (Carstensen et al., 2003; Clary and Snyder, 1999; Fung et al., 2001; Hendricks & Cutler, 2004, Wang et al., 2017). In the context of this research, relatedness might have been important for older adults as this includes social relations and competence is less important because this involves having or acquiring the necessary knowledge, skills, and abilities to effectively use an mHealth application. Hence, the first major finding of the present study suggests that emotional needs, such as having personal control and having a sense of belongingness, might be more important than knowledge-related goals, such as feeling competent to use an mHealth applications, for older adults to be more intrinsically motivated to use mHealth applications.

Predictors of mHealth Application Use of Older Adults

Furthermore, another substantial finding of the current study is that only the second subdimension of autonomy was associated with mHealth application use among older adults. Older adults who had a higher sense of personal control and the use of the mHealth app was suitable for them, were more likely to use mHealth applications than older adults who had a lower sense of personal control and felt that the app was less suitable for them. No significant differences were found for the first subdimension of autonomy, competence, relatedness, and intrinsic motivation. Therefore, the only predictor that was shown to be important for the use of mHealth applications was the feeling of personal control and the adequacy of the mHealth app. This is not in line with the existing literature that stated that motivation centered around personal value (i.e., intrinsic motivation) matters the most when it comes to the use of information communication technologies and is, therefore, an important determinant for the use of mHealth applications (Tyler et al., 2020). Intrinsic motivation might not play a significant role in the use of mHealth applications by older adults because older adults may perceive the use of mHealth applications as a necessity, for being psychically safe, rather than a choice driven by intrinsic motivation (Kuerbis et al.; 2017). Additionally, older adults may be more influenced by external factors such as recommendations of their healthcare provider, and family support rather than relying on their own intrinsic motivation (Cajita et al., 2018).

In addition, these results mean that for the actual use of mHealth applications, the need for relatedness is no longer a crucial factor even though it was an important factor for the intrinsic motivation to use mHealth applications. Therefore, it can be concluded that for older adults to be intrinsically motivated, they need both the second subdimension of autonomy and relatedness. However, to use mHealth applications they only require the second subdimension of autonomy. This could be because when they must use the mHealth application the social relations are no longer important. Social relations can help them to be motivated to use them and once they use them, they can do it on their own. Implying that older adults can use the mHealth app on their own does mean that the second subdimension of autonomy is still important because while using the mHealth application they want to be in control and the mHealth application should be suitable for them to be able to use the mHealth application.

Practical Implications

Overall, the results of this study contribute to our understanding of the factors influencing the use of mHealth applications by older adults. The findings suggest that addressing psychological needs, particularly the second subdimension of autonomy and relatedness, can enhance intrinsic motivation to use mHealth applications. In other words, addressing the emotional goals for using mHealth applications. Need for autonomy is closely tied to an individual's psychological well-being (Ryff, 1989). Additionally, need for relatedness is an emotional goal because this focusses on experiencing meaningful social relations and influences our emotional well-being (Ryan & Deci, 2000). Accordingly, developers and designers of mHealth applications should prioritize that features that provide emotional well-being and user satisfaction. These features could for example be notifications, progress tracking, and goal achievement. Users might feel supported when the app assists them in managing their health and provides users with a sense of accomplishment. When focusing on these aspects, developers can increase intrinsic motivation among older adults and encourage them to use mHealth applications.

Furthermore, the study highlights the importance of personal control and suitability in mHealth applications to increase the use of mHealth applications by older adults. This finding suggests that mHealth applications that offer customization and flexibility to meet individual needs and preferences are more likely to be used by older adults. By allowing users to customize their online environments, it promotes an active engagement with technology, thereby stimulating a feeling of control (Sundar, 2008; Kang & Sundar, 2016). Additionally, it can make the mHealth application suitable to each individual because they are able to customize it to their liking. Therefore, developers and designers of mHealth applications should consider creating autonomy-supportive environments, through customization, which has the potential to increase the autonomous motivation to use mHealth applications (Bol et al., 2019).

Limitations and Future Research

Despite the valuable insights provided by this study, it is essential to note some limitations. First, the survey gathered data through structured questions with predefined response options. This limited format might not have captured the complexity or nuances of the current topic. It can restrict the ability of respondents to fully express their thoughts or provide detailed explanations. Especially for older adults it might be hard to understand an online survey and what is meant by all the questions asked. Future studies can consider incorporating complementary qualitative methods to gather more detailed and nuanced insights. For example, by using ‘questerviews’, which means integrating standardized survey questions into qualitative interviews (Adamson et al., 2004). Questerviews offer a convenient and effective approach to investigate topics in health services research (Adamson et al., 2004). By combining qualitative approaches, such as interviews, focus groups, or open-ended questions, researchers can explore participants' perspectives, for example on the need for autonomy, in greater depth.

Additionally, the results of this study are binary (use vs. non-use), however, there are more distinctions regarding the use of mHealth applications such as frequency of use, different types of mHealth applications, and advantages when using certain mHealth applications. Investigating this variety of use can provide better insights into understanding the grey divide and mHealth application use. For instance, which mHealth applications are used by older adults and which mHealth applications are not, how frequently older adults use mHealth applications, understand why they are used or not used, and what benefits they gain from using certain mHealth applications. The results of these investigations can help provide mHealth applications that fulfil older adults' needs and that the mHealth applications provide favorable outcomes, which contributes to bridging the digital divide.

Furthermore, regarding the scales measuring the psychological needs, the scale of autonomy was not reliable. This has led to the division of autonomy into the first subdimension of autonomy and the second subdimension of autonomy. The first subdimension of autonomy was more related to the freedom to which they can use an mHealth application in their own way and this way is based on their own interests and values. The second subdimension of autonomy relates to the feeling of personal control when using mHealth applications and appropriateness of the mHealth application. Several reasons could exist why the scale measuring autonomy of older adults was not reliable. It could be that the scale did not include appropriate and comprehensive metrics to capture the concept of autonomy effectively. Autonomy is a complex concept that entails various aspects such as cognitive and social abilities (Deci & Ryan, 2004). If the scale failed to consider these aspects, it might have not provided a reliable measure of autonomy. Additionally, the reliability can also be influenced by the interpretation of the scale by the respondents. The scale relied on subjective judgments which could have caused human error and reduced the reliability. To address the issue of the reliability of autonomy, future research should develop a new scale for autonomy, preferably with more items that are appropriate and comprehensive to measure the concept of autonomy.

Conclusion

This study highlights the importance of psychological needs, specifically autonomy, relatedness, and intrinsic motivation regarding the use of mHealth applications among older adults. The results indicated that mHealth applications which were able to provide a sense of personal control and a feeling of relatedness increased older adults' intrinsic motivation and the use of mHealth applications. Specifically, the adequacy and sense of personal control are most important when it comes to mHealth application use. These findings contribute to bridging the digital divide in the context of the SDT and older adults. This study suggests opportunities how to design and develop mHealth applications to increase the use of these mHealth applications by older adults. The use of mHealth applications can be improved by adding customization and features that provide emotional well-being and user satisfaction. Future studies should focus on gaining broader insights, especially when it comes to the concept need for autonomy. When applying the previous insights, the ability of mHealth applications to improve health outcomes and quality of life for older adults can be utilized in today's increasingly digital world.

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Appendix A

Dutch Version of the Questionnaire

Below, the survey that was used for this study can be found.

Motivatie voor het gebruik van mobiele gezondheidsapplicaties bij ouderen

Geachte deelnemer,

Mijn naam is Imke Janssen en op dit moment studeer ik Communicatie- en Informatiewetenschappen aan de Tilburg Universiteit. Voor mijn masterscriptie ben ik op zoek naar volwassenen van 65 jaar en ouder die een vragenlijst willen invullen over hun motivatie voor het gebruik van mobiele gezondheidsapplicaties. Ik kan uw hulp daarom goed gebruiken.

Deze enquête bevat vragen over het gebruik van mobiele gezondheidsapps. Het invullen van de vragenlijst duurt ongeveer 10 minuten. Er zijn geen goede of foute antwoorden. De antwoorden zijn volledig anoniem. De resultaten worden gerapporteerd zonder dat enige identificatie mogelijk is. U heeft het recht om de enquête op elk moment stop te zetten zonder hiervoor een reden te geven. De gegevens die u invult zijn voor mij van grote waarde en worden met de grootste zorgvuldigheid behandeld.

Mochten er naar aanleiding van uw deelname aan dit onderzoek bij u vragen, opmerkingen of klachten zijn over het onderzoek en de daarbij gevolgde procedure, dan kunt u contact opnemen met Imke Janssen (i.p.h.janssen@tilburguniversity.edu).

Ik hoop u hiermee voldoende te hebben geïnformeerd en dank u bij voorbaat hartelijk voor uw deelname aan dit onderzoek.

Met vriendelijke groet,

Imke Janssen

CONSENT
Ik stem geheel vrijwillig in met deelname aan dit onderzoek. Ik behoud daarbij het recht deze instemming weer in te trekken zonder dat ik daarvoor een reden hoef op te geven. Ik besef dat ik op elk moment mag stoppen met het onderzoek. Als mijn onderzoeksresultaten gebruikt worden in wetenschappelijke publicaties, of op een andere manier openbaar worden gemaakt, dan zal dit volledig geanonimiseerd gebeuren. Mijn persoonsgegevens worden niet door derden ingezien zonder mijn uitdrukkelijke toestemming en worden voor een periode van 2 maanden bewaard.

Als ik meer informatie over het onderzoek wil, nu of in de toekomst, dan kan ik me wenden tot Imke Janssen (i.p.h.janssen@tilburguniversity.edu).

- ◯ Ik ga akkoord met deelname aan dit onderzoek
- ◯ Ik zie af van deelname aan dit onderzoek

Wat is uw leeftijd?

- ◯ Jonger dan 65
- ◯ 65-70
- ◯ 71-75
- ◯ 76-80
- ◯ 81-85
- ◯ 86+

Wat is uw geslacht?

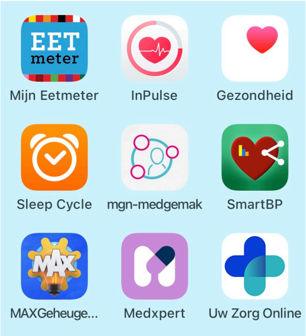
- ◯ Man
- ◯ Vrouw
- ◯ Anders, namelijk: ____
- ◯ Zeg ik liever niet

Wat is uw woonsituatie?

- ◯ Ik woon samen met mijn partner
- ◯ Ik woon alleen/zelfstandig
- ◯ Ik woon in een verzorgingshuis
- ◯ Ik woon met (klein)kinderen
- ◯ Anders, namelijk:____

INTRO2a
Deze vragenlijst gaat verder met enkele vragen over uw gebruik van gezondheidsapps via mobiele apparaten. Dit zijn apps waarmee u uw gezondheidsgegevens bij kunt houden. Er zijn verschillende soorten apps met verschillende functies, zoals apps die informatie bijhouden, opslaan en delen (e.g. het monitoren van iemands hartslag) en communicatieapps (bijv. chatten/beeldbellen met de zorgverlener).

De gegevens die u bijhoudt worden vaak opgeslagen in een app. Een app is een computerprogramma dat geïnstalleerd kan worden op mobiele apparaten. Dit kan bijvoorbeeld via uw smartphone, tablet, websites of wearable (bijv. Apple Watch of FitBit). Hieronder ziet u een voorbeeld van verschillende soorten gezondheidsapps.



SMART
Maakt u weleens gebruik van een smartphone, tablet of wearable?

- Een smartphone is een mobiele telefoon die computermogelijkheden biedt, zoals internetten en online bankieren.
- Een tablet is een platte mobiele computer met een groot touchscreen, zoals bijvoorbeeld een iPad.
- Een wearable is een draagbare sensor die op het lichaam gedragen kan worden, zoals bijvoorbeeld een smartwatch (Apple Watch) of FitBit.

	Ja (1)	Nee (2)	Ik weet het niet (3)
Smartphone (1)	○	○	○
Tablet (2)	○	○	○
Wearable (3)	○	○	○

INTRO2b De volgende vragen gaan over wat u vindt van gezondheidsapps voor bijhouden van uw gezondheid. Hierbij kunt u denken aan het bijhouden van uw beweging, slaap, voeding, hartslag of bloeddruk. Als u geen gezondheidsapps gebruikt, dan willen we u vragen zich voor te stellen dat u gezondheidsapps zou gebruiken.

AUTONOMY
In hoeverre bent u het eens met de volgende stellingen?

Als u geen gezondheidsapps gebruikt, maakt u bij deze stellingen dan een inschatting van wat u zou vinden als u gebruik zou maken van gezondheidsapps.

	Helemaal mee oneens (1)	(2)	(3)	(4)	(5)	(6)	Helemaal mee eens (7)
Ik heb het gevoel dat ik vrij ben om een gezondheidsapp te gebruiken op mijn eigen manier. (1)	○	○	○	○	○	○	○
Ik heb het gevoel dat de keuze om een gezondheidsapp te gebruiken is gebaseerd op mijn eigen interesses en waarden. (2)	○	○	○	○	○	○	○
Ik heb het gevoel dat het gebruik van een gezondheidsapp bij mij past. (3)	○	○	○	○	○	○	○
Ik heb het gevoel dat ik controle heb over mijn gezondheid als ik een gezondheidsapp gebruik. (4)	○	○	○	○	○	○	○

COMPETENCE
In hoeverre bent u het eens met de volgende stellingen?

Als u geen gezondheidsapps gebruikt, maakt u bij deze stellingen dan een inschatting van wat u zou vinden als u gebruik zou maken van gezondheidsapps.

	Helemaal mee oneens (1)	(2)	(3)	(4)	(5)	(6)	Helemaal mee eens (7)
Ik ben in staat om een gezondheidsapp te gebruiken. (1)	○	○	○	○	○	○	○
Ik ben in staat om uitdagingen (bijv. leren hoe je een bepaalde functie in een gezondheidsapp moet gebruiken) aan te gaan bij het gebruik van een gezondheidsapp. (2)	○	○	○	○	○	○	○
Ik heb de juiste vaardigheden en capaciteiten om een gezondheidsapp te gebruiken. (3)	○	○	○	○	○	○	○
Ik ben in staat om een gezondheidsapp te gebruiken voor mijn gezondheidsdoelen (bijv. het op de juiste manier meten van mijn hartslag). (4)	○	○	○	○	○	○	○

RELATEDNESS
In hoeverre bent u het eens met de volgende stellingen?

Als u geen gezondheidsapps gebruikt, maakt u bij deze stellingen dan een inschatting van wat u zou vinden als u gebruik zou maken van gezondheidsapps.

	Helemaal mee oneens (1)	(2)	(3)	(4)	(5)	(6)	Helemaal mee eens (7)
Als mensen om mij heen een gezondheidsapp gebruiken wil ik dat ook doen. (1)	○	○	○	○	○	○	○
Door het gebruik van een gezondheidsapp voel ik me verbonden met de mensen die voor mij zorgen en voor wie ik zorg. (2)	○	○	○	○	○	○	○
Het gebruik van een gezondheidsapp geeft me meer kansen om met anderen om te gaan (bijv. mensen met dezelfde gezondheidszorgen). (4)	○	○	○	○	○	○	○
Door het gebruik van een gezondheidsapp heb ik een gevoel dat de afstand tot mijn zorgverleners kleiner wordt. (5)	○	○	○	○	○	○	○

INTRINSIC MOTIVATION
In hoeverre bent u het eens met de volgende stellingen?

Als u geen gezondheidsapps gebruikt, maakt u bij deze stellingen dan een inschatting van wat u zou vinden als u gebruik zou maken van gezondheidsapps.

	Helemaal mee oneens (1)	(2)	(3)	(4)	(5)	(6)	Helemaal mee eens (7)
Ik vind het interessant om met mijn gezondheid bezig te zijn door middel van gezondheidsapps. (1)	o	o	o	o	o	o	o
Ik wil meer wil weten over mijn gezondheid door middel van gezondheidsapps. (2)	o	o	o	o	o	o	o
Ik vind het leuk om met mijn gezondheid bezig te zijn door middel van gezondheidsapps. (3)	o	o	o	o	o	o	o
Ik wil gezond blijven door middel van gezondheidsapps. (4)	o	o	o	o	o	o	o

INTRO3_st
We vragen u nu om uw smartphone of tablet te pakken. Mocht u meerdere smartphones en tablets bezitten neem alstublieft de smartphone of tablet die u het meest gebruikt.

Zodra u uw smartphone/tablet bij de hand hebt: klik alstublieft op de volgende button rechts onderin. Als het niet mogelijk is om uw smartphone/tablet erbij te pakken, geef dan bij de volgende vragen uw beste inschatting.

APPS1_s
Als het goed is hebt u nu uw smartphone/tablet bij de hand (of u maakt een inschatting bij de volgende vragen).

Kijk alstublieft nu op uw smartphone/tablet en tel **alle gezondheidsapps** die op uw smartphone/tablet staan.
U kunt hierbij denken aan de volgende voorbeelden:
- apps voor de hartslag
- apps voor slaap
- apps voor humeur en/of stemmingswisselingen
- apps voor fitness, sport en/of beweging, zoals een stappenteller
- apps voor voeding, gewicht en/of dieet, zoals een eetdagboek
- apps voor ziekte en/of behandeling, zoals een diabetes app
- apps voor mentale gezondheid, zoals meditatie apps
- apps voor communicatie met uw zorgverlener (bijv. d.m.v. beeldbellen, e-mailen of chatten)

Geef hieronder aan hoeveel gezondheidsapps in totaal op uw smartphone/tablet staan, ook als u deze niet gebruikt.
Als u geen gezondheidsapps hebt, klikt u dan aan 'ik heb geen gezondheidsapps'.

○ Ik heb ... gezondheidsapps (vul het precieze aantal hieronder in)

____

○ Ik heb geen gezondheidsapps

APPS2_s
U hebt aangegeven dat u gezondheidsapps op uw smartphone/tablet hebt staan.

Schrijf hieronder alstublieft de namen op van uw gezondheidsapp(s), ook als u deze niet gebruikt. U kunt maximaal 5 gezondheidsapps invullen. Als u er meer dan 5 apps gebruikt, noem dan de 5 meest gebruikte gezondheidsapps.

○ 1 (1) ____

○ 2 (2) ____

○ 3 (3) ____

○ 4 (4) ____

○ 5 (5) ____

APPS3_st
Hoe vaak gebruikt u deze gezondheidsapps om gezondheidsgegevens bij te houden?

	Meedere keren per dag (1)	(bijna) elke dag (2)	Aantal keer per week (3)	Ong. 1 keer per week (4)	Aantal keer per maand (5)	Ong. 1 keer per maand (6)	Aantal keer per jaar (7)	Ong. 1 keer per jaar (8)	Nooit (9)
1 (x1)	○	○	○	○	○	○	○	○	○
2 (x2)	○	○	○	○	○	○	○	○	○
3 (x3)	○	○	○	○	○	○	○	○	○
4 (x4)	○	○	○	○	○	○	○	○	○
5 (x5)	○	○	○	○	○	○	○	○	○

DEBRIEF
Hartelijk dank voor uw medewerking aan het onderzoek. Uw deelname is van grote waarde. Uw gegevens zullen vertrouwelijk worden behandeld en anoniem worden opgeslagen en verwerkt. Mocht u nog vragen hebben over het onderzoek, of mocht u een rapportage over de resultaten willen ontvangen na afronding van dit onderzoek, dan kunt u contact opnemen met Imke Janssen, per e-mail op i.p.h.janssen@tilburguniversity.edu. Klik op de knop rechtsonder om uw antwoorden op te slaan.

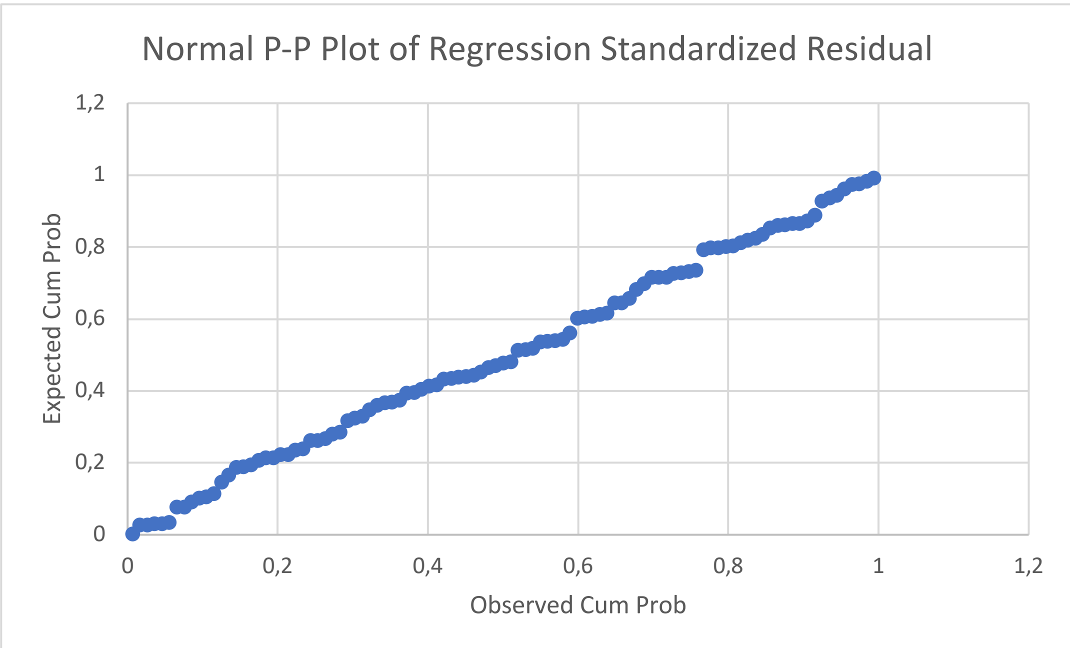
Appendix B

Assumptions Explained

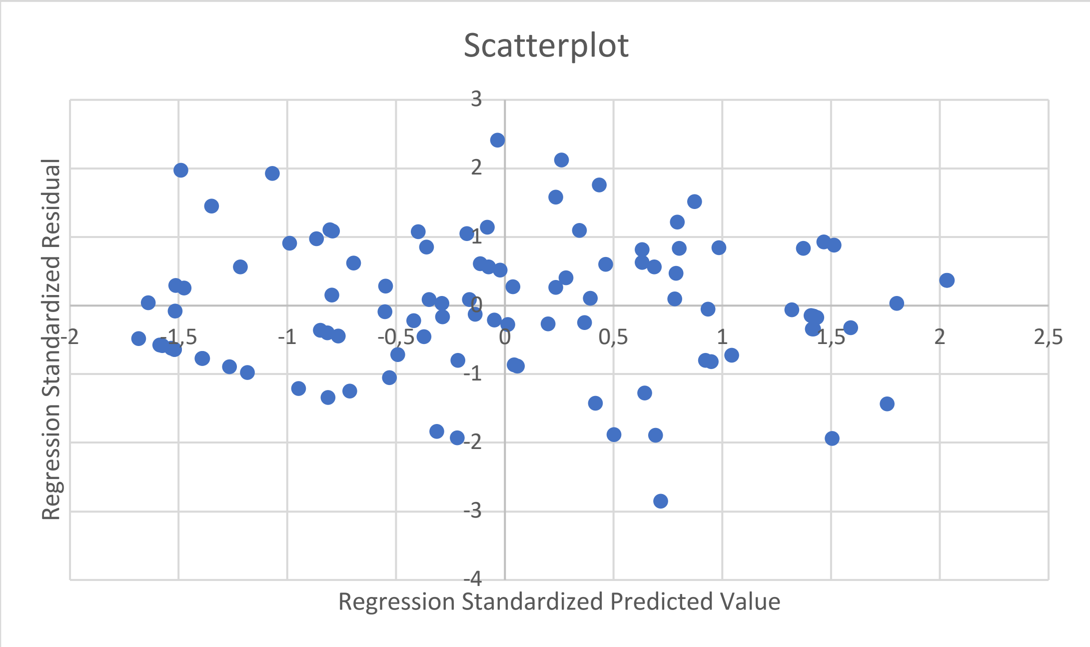
To be able to run and interpret the results of both the multiple regression analysis the assumptions of outliers, normality, homoscedasticity, linearity, multicollinearity, and independence of errors need to be checked. If the assumptions are met, the analysis can be run and interpreted. Additionally, for the logistic regression analysis some assumptions need to be checked. These assumptions are outliers, linearity, and multicollinearity. The assumptions for both analyses are displayed below.

Multiple Regression Analysis

1. Outliers: The normal regression output showed that there are no outliers because the z-scores were lower than 3 and higher than -3. The residuals statistics showed that the minimum value was -2.85 and the maximum value was 2.41.
2. Normality: The normal regression output, the normal P-P plot showed that normality can be assumed for the data of the current study. There is a little bit of deviation, but this is still ok. There are not drastic deviations.



3. Homoscedasticity: The scatterplot of the residuals showed that the points are equally distributed above and below zero on the X axis and to the left and right of zero on the Y axis. This suggests that the data are homoscedastic.



4. Linearity: The residuals are normally distributed and homoscedastic which means that the predictor variables have a straight-line relationship with the outcome variable.
5. Multicollinearity: The VIF values for all predictors are all below 10, indicating that the assumption of multicollinearity is met.
6. Independence of errors: The Durbin-Watson value should be between 1 and 3 to have no correlation. The data met the assumption of independent errors because there is no autocorrelation (Durbin-Watson value = 2.22).

Logistic Regression Analysis

1. Outliers: The normal regression output showed that there are no outliers because the z-scores were higher than -3 and lower than 3. The residuals statistics showed that the minimum value was -2.10 and the maximum value was 1.65.
2. Linearity: To check the linearity of the continuous independent variables and the logit (log odds) transformation, a Box-Tidwell test was used. A logistic regression assumes

linearity of independent variables and log odds. The analysis does not require the dependent and independent variables to be related linearly, it does require that the independent variables are linearly related to the log odds. The Box-Tidwell test showed that the latter is true because all log odds are non-significant.

3. Multicollinearity: The VIF values for all predictors are all below 10, indicating that the assumption of multicollinearity is met.