The Effects of Using a Mobile Wellness Application on Physical Activity Levels: A Four-Month Follow-Up Study Among Aged People

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Abstract Insufficient physical activity threatens people in older age. Thus, finding ways to support a physically active life in the older age is important. Digital wellness technologies have been presented as potential solutions, but in order for these solutions to be effective, research to gain insights on their use among aged people is needed. This study investigated how the use of a mobile wellness application for tracking physical activity affects physical activity levels among aged people. The physical activity levels were measured by using the IPAQ-E. The focus was on the first four months of use. The study was part of a research program in which groups of aged people take into use a mobile wellness application. The results show a modest, however, statistically not significant increase in the physical activity levels after the first four months of use. The study suggests that digital wellness technologies have potential for promoting physical activity levels among aged people.

Keywords: digital wellness, wellness technology, mobile, wellness application, mobile application.

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1 Introduction

The ageing population is increasing: persons aged 65 years or older already represent around 18–22 % of the population in most EU countries, and the share is increasing in every EU member state (Eurostat, 2019). On a global scale, the number of people aged over 65 years is projected to double to 1.5 billion by the year 2050 (United Nations, 2019). At the same time, the life expectancy at older ages is improving: globally, a person aged 65 was expected to live additional 17 years in 2015–2020, which is expected to increase to additional 19 years by 2045–2050 (United Nations, 2019). This makes aged people an increasing priority area for policy makers and healthcare providers worldwide and raises an important question: how to support aged people to live a physically active life in older age?

This is a vital question as physical activity (PA) has significant health benefits across all age groups and contributes to the prevention of non-communicable diseases. Insufficient PA, on the other hand, is a global problem across all age groups and one of the leading risk factors for non-communicable diseases and death worldwide (WHO, 2018). The World Health Organization (WHO) provides research-based guidelines and recommendations for PA. These guidelines state, for example, that adults aged 65 years or older should do at least 150 minutes of moderate-intensity PA or at least 75 minutes of vigorous-intensity PA per week, or an equivalent combination of these. For additional health benefits, they should increase moderate-intensity PA to 300 minutes per week or equivalent. Additional PA to enhance balance and muscle-strength as well as to prevent falls should also be conducted (WHO, 2018). PA is imperative to ward off age-related illness and frailty (Hoogendijk et al., 2019). Moreover, several studies (e.g., Jonasson, 2017) show that systematic PA contributes to a better quality of life during older age.

Researchers in various fields have launched serious efforts to find solutions to support PA in different age groups. Digital wellness technologies, that is, *digital technologies that can be used to support different aspects of wellness*, have been presented as one potential solution. These include, for example, devices, applications, and services. For these to be effective, research is needed to gain insights on how they are used and what is the effect of their use specifically among aged people, as they form a user group with distinct needs and challenges. Research on the topic is also important in order to optimize the development of digital wellness technologies for aged people so that the use would support PA.

The main purpose of this study was to investigate the following research question: Does using a mobile wellness application for four months affect the PA levels among aged people? The self-reported PA levels were measured before taking the application into use and after four months of use by using the International Physical Activity Questionnaire modified for the elderly (IPAQ-E) (Hurtig-Wennlöf et al., 2010). This study is part of a research program in which, among other things, groups of aged people take into use a mobile wellness application meant for tracking, following, and supporting their PA.

2 Digital Wellness Technologies

There are various digital wellness technologies, such as devices, applications, and services aimed for diverse target groups with different PA levels. The popularity of such technologies has increased greatly, and they are used by various types of users (Kettunen et al., 2017; Moilanen et al., 2014). However, these technologies are still mostly designed for younger populations, while a growing need among aged people is prevalent (Carlsson & Walden, 2017). Digital wellness technologies can support PA in various ways. For example, they can be used to increase PA levels – albeit with modest evidence (e.g., de Vries et al., 2016; Larsen et al., 2019; Romeo et al., 2019), and to reduce sedentary behaviors (e.g., Stephenson et al., 2017). They can support goal-setting (e.g., Gordon et al., 2019; Kirwan et al., 2013), provide instructions and digital coaching (e.g., Kari & Rinne, 2018; Kettunen & Kari, 2018; Sell et al., 2019), and provide social support (e.g., Sullivan & Lachman, 2017). They can also make PA more entertaining through exergames (e.g., Kari, 2014; Kari et al., 2020; Loos & Zonneweld, 2016) or gamification (Kari et al., 2016; Koivisto & Hamari, 2019). Digital wellness technologies can provide feedback in many forms, which can increase the users' awareness of personal PA and motivate towards it (e.g., Kang et al., 2009; Kari et al., 2017; Wang et al., 2016). However, an increased awareness of personal PA is not always enough for a continued use of the technology (Kari et al., 2017; Miyamoto et al., 2016), which, in turn, can disturb the maintenance of PA routines (Attig & Franke, 2020; Warraich, 2016). The potential of digital wellness technologies to promote PA among aged people has also been proposed, but questions have been raised regarding their effectiveness, and more research is called for (e.g., Allmér, 2019; Larsen et al., 2019; Seifert et al., 2017.)

3 Methodology

3.1 The Application Used in the Study

The mobile wellness application used in the study is an application that is designed and developed in an ongoing research program run by the authors. It is an application within an application and operates inside the Wellmo application platform (Wellmo, 2019), which supports Android and iOS operating systems and in which the application features constitute their own entity. The application is aimed to support the forming of wellness routines in everyday life and is designed specifically for the aged people. The central features of the application are related to tracking PA. The application includes, for example, features for tracking and following one's conducted PA, weekly and monthly reports about the conducted PA, and the possibility to import data from external wellness services supported by the Wellmo application platform, such as Polar, Fitbit, Apple Health, and Google Fit. The application is under continuous development, and new versions are planned to be released twice a year with new features to support PA.

3.2 Research Setting, Data Collection, and Analysis

This study has a quantitative approach. The main purpose was to investigate the changes in PA levels before and after a four-month use period of a mobile wellness application. The study was based on the first field phase of the authors' ongoing research program mentioned in the previous section. In June 2019, the first wave of field groups with a total of 142 participants took the application into use. These groups acted as pilot groups before the next wave of field groups was launched in November 2019. Each group had one field researcher who, among other things, assisted in taking the application into use and educated the users on how to use the application. The study was conducted in Finland, and all the field groups were recruited via the Finnish pensioners' associations. During the first phase of the use which lasted four months (from June to October 2019), the participants used the application in their daily lives and conducted physical activities according to their own preferences. That is, they were not given any particular PA programs to follow or specific goals to reach out for but could freely do what they wanted and when they wanted. The application and its use were free for the participants. However, the participants were required to have a smartphone of their own.

The focus of this study was on the first four months of use, meaning that the PA levels were measured before taking the application into use and after four months of use. The self-reported PA levels were measured by using the IPAQ-E (Hurtig-Wennlöf et al., 2010). The IPAQ-E is a modified version of the short-format IPAQ (Craig et al., 2003) validated with Swedish adults (Ekelund et al., 2006), and has been culturally adapted and validated for the elderly (Hurtig-Wennlöf et al., 2010). The IPAQ and IPAQ-E are specifically designed to provide a set of well-developed instruments that can be used internationally to obtain comparable estimates of PA (IPAQ group, 2005a). The IPAQ is the most widely used and validated PA questionnaire (Lee et al., 2011; van Poppel et al., 2010). The IPAQ-E focuses on collecting self-reported PA data concerning sitting time, walking, moderate PA, and vigorous PA from a period of the last seven days. For this study, the IPAQ-E questionnaire was translated from Swedish to Finnish with the help of the Finnish version of the short-format IPAQ questionnaire. Participants were Finnish and Swedish speaking (official languages in Finland), and thus, both language versions were used. The used questionnaires are available from the authors by request.

The data for this study were collected from the first wave of field groups. The first round of data collection took place in June 2019 and the second (follow-up) during November 2019. The data were collected with printed IPAQ-E questionnaires that were handed to the participants in field meetings organized with each field group separately. Before answering the questionnaire, the researchers responsible for the data collection gave oral and written instructions on filling and answering. No time limit was set for answering, and the participants could ask for clarifications if they felt the need. All participants gave a written informed consent. The local ethical committee was contacted before the start of the research program, and it was deemed that no separate approval was needed for this study.

The collected data were analyzed with the IBM SPSS Statistics 24 software. For the analysis, the *Guidelines for the data processing and analysis of the International Physical Activity Questionnaire* (IPAQ group, 2005b) and the guidelines presented by Hurtig-Wennlöf et al. (2010) were followed. Following the insights by Hurtig-Wennlöf et al. (2010, p. 1853), the PA data (continuous variable) are presented in *time in minutes spent in different intensities* instead of converting into metabolic equivalent of task values (MET) and MET-minutes (MET-min); and following the guidelines by the IPAQ group (2005b), the PA data are presented in *median minutes/week* rather than means; additionally, the interquartile ranges are presented. In addition to analyzing the PA levels, the participants were categorized into three PA categories (categorical variable: low, moderate, and high) based on the reported time of each activity in combination with a weighting factor for the different activities (i.e., a factor 3.3 for walking, 4.0 for moderate PA, and 8.0 for vigorous PA) (for details, see Hurtig-Wennlöf et al., 2010). Before the analysis, the standard methods for the cleaning and treatment of IPAQ datasets were conducted as advised in the *Guidelines for the data processing and analysis of the International Physical Activity Questionnaire* (IPAQ group, 2005b, p. 10-11). For example, in accordance with the truncation of data rules, if the reported times for walking, moderate, and vigorous activities exceeded 180 min/day, data were truncated to be equal to 180 min/day (IPAQ group, 2005b; Hurtig-Wennlöf et al., 2010).

The statistical significance of the changes over the four-month use period in the continuous variable were analyzed with the Wilcoxon (1945) signed-rank test because the focus was on medians rather than means. In turn, the statistical significance of the changes in the categorical variable were analyzed with the McNemar-Bowker test (Bowker, 1948). The level of statistical significance of both the tests was set to $p < 0.05$. The potentially missing values were handled by excluding the responses of a particular participant to a particular item if s/he had not responded to it in both data collection rounds. Thus, the exact number of respondents (N) may slightly vary between the items.

4 Results

In total, there were 142 participants in the first wave of field groups, out of which 99 responded to the IPAQ-E in both data collection rounds. Of them, 35.4 % were male and 64.6 % were female. The average age of the participants was 68.8 years (standard deviation 4.9 years). Descriptive statistics of those 99 participants are reported in Table 1.

Table 1: Descriptive statistics of the sample (N=99)

	n	%
Gender		
Male	35	35.4
Female	64	64.6
Other	0	0.0
Age		
Under 60 years	3	3.0
60–64 years	10	10.1
65–69 years	41	41.4
70–74 years	32	32.3
75 years or over	13	13.1
Language		
Finnish	65	65.7
Swedish	34	34.3

4.1 Analysis of the Continuous Variable (PA Levels)

Following Hurtig-Wennlöf et al. (2010, p. 1853) and the guidelines by the IPAQ group (2005b), the PA data are reported here in *median minutes/week spent in different intensities*, together with the interquartile ranges. These are reported for before and after the four-month use period along with the statistical significance of the changes from the Wilcoxon signed-rank test (Table 2).

Table 2: Changes in median minutes/week spent in different intensities (N=99)

		Before (min/week)		After (min/week)		p
Self-reported from the IPAQ-E	**n**	**Median**	**25th–75th percentile**	**Median**	**25th–75th percentile**	
Sitting	87	2100	1260–2520	2100	1680–2940	0.156
Walking	90	600	311–903	630	420–1050	0.076
Moderate activity	92	260	150–540	270	165–443	0.412
Vigorous activity	96	60	0–300	120	4–240	0.931

Regarding the changes in the *median minutes per week spent in different intensities*, there was a modest increase in walking, moderate activity, and vigorous activity. However, none of the changes were statistically significant. The median minutes per week for sitting remained unchanged.

4.2 Analysis of the Categorical Variable (PA Category)

The changes in the PA category were investigated by examining the changes in the number of participants in the PA categories Low, Moderate, and High (based on the IPAQ-E PA categorization) (Table 3). More precisely, it was investigated how many were increasingly active (i.e., moved from Low → Moderate/High or Moderate → High), decreasingly active (i.e., moved from High → Moderate/Low or Moderate → Low), or equally active (i.e., stayed in the same category) (Table 4).

Table 3: Changes in the number of participants in the different PA categories (N=99)

	Before		After	
PA category	**n**	**%**	**n**	**%**
Low	10	10.1	4	4.0
Moderate	23	23.2	23	23.2
High	66	66.7	72	72.7

Table 4: Changes in the PA categories after the four-month use period (N=99)

PA category	**After:** Low	**After:** Moderate	**After**: High
Before: Low	1	2	7
Before: Moderate	0	10	13
Before: High	3	11	52

Of the participants, 22.2 % were increasingly active, 14.1 % were decreasingly active, and 63.6 % were equally active after the four-month use period. The equally active participants could belong to any of the three PA categories. Interestingly, all but one of the ten participants who were initially in the Low category, increased their PA to Moderate or High. However, the McNemar-Bowker test suggested that the overall increase/decrease in PA was statistically not significant ($\chi2(3) = 3.767$, $p = 0.288$).

5 Discussion

The main purpose of this study was to investigate the following research question: Does using a mobile wellness application for four months affect the PA levels among aged people? The study participants took into use a mobile wellness application that allowed them to track and follow their PA. The self-reported PA levels were measured before taking the application into use and after four months of use by using the IPAQ-E.

Regarding the PA levels, the changes in four types of PA (sitting, walking, moderate activity, and vigorous activity) were measured. In general, the results show a modest increase in the PA levels after the first four months of use. Whereas the median minutes per week spent in sitting remained unchanged, modest increases were observed in the median minutes per week spent in walking, moderate PA, and vigorous PA. However, although these changes suggested an improved PA level concerning these physical activities, they were statistically not significant at the $p < 0.05$ level. To summarize the answer to the research question, the four-month use period of a mobile wellness application had a slightly positive, although statistically not significant, effect on the PA levels of the participating aged people. In general, this is in line with the findings of Larsen et al (2019), who conducted a systematic review on the ability of physical activity monitors to enhance the amount of physical activity in older adults.

The participants were further categorized into three PA categories based on their overall PA level. These categories, as detailed by Hurtig-Wennlöf et al. (2010), were low, moderate, and high. The shifts of individual participants from one category to another were investigated. Overall, 22.2 % of the participants were increasingly active, 14.1 % were decreasingly active, and 63.6 % were equally active after the four-month use period. When examining this in detail, especially a shift from the low and moderate PA categories to the high PA category could be observed. However, a shift to the other direction was also observed as some people in the high PA category shifted to lower PA categories. A shift to a lower PA category may be explained by any incidents or other changes in the life of a participant. For example, if a highly active person faces an injury or other barriers to exercise, s/he is likely not able to conduct as much PA and, as a result, shifts towards lower PA categories. For people in the moderate PA category, such hindrances are logically not likely to have an equally great effect, and even less so for people in the low PA category. However, confirming the reasons behind shifting to a lower PA category would require detailed (qualitative) research on the individual cases in question.

It should also be noted that a relatively high number of the participants (66.7 %) belonged to the high(est) PA category (based on the IPAQ-E PA categorization) already before taking the application into use, and thus, they obviously could not shift to a higher PA category. Respectively, only 10.1 % of the participants belonged to the low(est) PA category before taking the application into use. This of course means that there were considerably more participants who could shift to a lower PA category compared to participants who could shift to a higher PA category. In spite of this, the participants rather shifted to a higher PA category than to a lower PA category after the four-month use period, although the overall changes in PA in terms of these shifts was found to be statistically not significant.

On average, the participants seemingly represented a physically more active share of the aged population (66.7 % in the high PA category). This is likely to downplay the possibility of the positive changes in the PA levels. For example, Kononova et al. (2019) who researched wearable activity tracker use among older adults found that the use gave the greatest benefits to former nonusers who were less active. Thus, it is plausible that the potential of mobile wellness applications in promoting PA levels among aged people is greater than the quantitative results of this study would suggest. To conclude, this study suggests that digital wellness technologies have potential for promoting physical activity levels among aged people, but more research is needed.

6 Limitations & Future Research

Some limitations of the study should be acknowledged. First, the participants were not necessarily tracking their PA before taking the application into use, and thus, they might have had a less accurate view on their initial PA level. With the use of a tracking application, an individual is likely to become more aware of his/her PA level, and thus, the latter measurement of PA might be more accurate. Second, the timing of the study might have influenced the results. The initial PA level from the period of the last seven days was collected in summer, whereas the four-month period ended in autumn. Obviously, the time of the year may have manifold effects on the PA levels of an individual. Third, on average, the participants represented a physically more active share of the aged population, which limits the findings. Future research should pay special attention to recruiting participants from all PA categories. Fourth, the relatively short use period is likely to limit the results. Thus, future research calls for longer periods of use to investigate longer-term effects. Fifth, lack of a control group can be seen as a limitation, as we cannot explicitly be sure whether the measured changes were more due to using the application itself or due to being part of the study. Future research could also investigate the effects of using a mobile wellness application in different age groups or in different countries, or by focusing on other types of digital wellness technologies.

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