STAGES OF EXERCISE BEHAVIOR CHANGE IN A DIGITAL WELLNESS PROGRAM FOR AGED PEOPLE: RELATIONSHIP WITH SELF-EFFICACY FOR EXERCISE

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Abstract Sustained physical activity and exercise are central to healthy ageing. Yet, the majority of aged people are insufficiently physically active. Digital wellness technologies are potential in promoting exercise behaviors among aged people, but more detailed research on their potential to promote behavior change is limited. To address this gap, the purpose is to investigate how partaking in a digital wellness program influences the stage of exercise behavior change among aged people and to test whether self-efficacy for exercise can differentiate the program participants in terms of the stages of change. The investigation builds on the stages of exercise behavior change derived from the transtheoretical model of behavior change and on self-efficacy for exercise. The results suggest that partaking in a digital wellness program can be effective in promoting exercise behavior change among aged people and show that self-efficacy for exercise may differentiate aged people at different stages of exercise behavior change.

Keywords: digital wellness, wellness technology, mobile wellness application, physical activity, aged people, young elderly, transtheoretical model, stages of change, follow-up study, physical activity application.

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1 Introduction

Aged people form an important target group for actions that aim to promote physical activity (PA) and exercise behaviors. Practically all countries globally are undergoing a growth in the proportion of the older population while the life expectancy at older ages is improving (United Nations, 2019). Thus, supporting healthier ageing is increasingly important. PA and exercise have significant health benefits and contribute to the prevention of non-communicable diseases (WHO, 2020), support maintaining the ability to function, and help to protect against age-related illness and frailty (Hoogendijk et al., 2019). Despite the World Health Organization (WHO) and several national health institutes providing research-based recommendations and guidelines for PA and exercise, insufficient PA is a major global problem in all age groups (WHO, 2020). For example, in Finland, where the present study was conducted, only around one-fourth of the people over 60 years of age meet these recommendations (THL, 2019). To support healthier ageing, solutions that would help aged people in their PA and exercise behavior change are increasingly needed.

Digital wellness technologies (DWT), that is, "digital technologies that can be used to support different aspects of wellness" (Kari et al., 2021), as well as related digital wellness programs are seen as prospective solutions (e.g., Carlsson & Walden, 2017). Their potential to promote PA and exercise behaviors among aged people has been suggested (e.g., Seifert et al., 2018; Stockwell et al., 2019), but research on their potential to promote behavior change is limited. To address this gap, the purpose of the present study is to investigate 1) *how partaking in a digital wellness program influences the stage of exercise behavior change among aged people*, and to test 2) whether *self-efficacy for exercise can differentiate the program participants in terms of the stages of change*. The investigation builds on the stages of exercise behavior change (Gorely & Gordon, 2005; Marcus et al., 1992), which is derived from the transtheoretical model of behavior change (Prochaska & DiClemente, 1983), and on self-efficacy for exercise (Resnick & Jenkins, 2000).

The study contributes to the stream of research on the ability of DWTs and related programs to support PA and exercise behavior change and provides further insights on the relationship between the stages of exercise behavior change and self-efficacy for exercise among aged people. As a practical contribution, insights for those managing digital wellness programs are given.

2 Background

2.1 Digital wellness technology use and behavior change

One of the underlying reasons for using DWTs is the expected positive effects on wellness behavior and outcomes. By using DWTs, the users are receptive to potential changes in their related behavior. Oinas-Kukkonen (2013) points out that "information technology always influences people's attitudes and behaviors in one way or another", either intendedly or unintendedly. In this idea, Oinas-Kukkonen (2013) presented the concept of behavior change support system (BCSS), defined as "a socio-technical information system with psychological and behavioral outcomes designed to form, alter or reinforce attitudes, behaviors or an act of complying without using coercion or deception".

Different DWTs can act as BCSSs in various ways. By using DWTs, users are exposed to user experiences that can act as a stimulus for future behaviors (e.g., Kari et al., 2016a; Karppinen et al., 2016) and persuade positive or negative behavior changes (Oinas-Kukkonen, 2013). Common features that can support behavior change include, for example, feedback (e.g., Wang et al., 2016), goal-setting (e.g., Gordon et al., 2019; Kirwan et al., 2013), digital coaching (e.g., Kari & Rinne 2018; Kettunen et al., 2020), social support (e.g., Sullivan & Lachman, 2017), gamification (e.g., Kari et al., 2016b; Koivisto & Hamari, 2019), and exergaming (e.g., Kari et al., 2020; Loos & Zonneweld, 2016).

Among aged people, DWTs have been shown to be potential in supporting positive changes in wellness and exercise-related behaviors (e.g., Changizi & Kaveh, 2017; Kari et al., 2021; Larsen et al., 2019; Muellmann et al., 2018; Stockwell et al., 2019; Yerrakalva et al., 2019) as well as in related factors, such as self-efficacy (e.g., Changizi & Kaveh, 2017; Kari et al., 2022). However, users sometimes face also negative or detrimental experiences with these technologies (Rockmann, 2019). Further, the technology needs to be perceived as compatible with the user's current exercise habits (Makkonen et al., 2012).

2.2 Transtheoretical model of exercise behavior change

The transtheoretical model (Prochaska & DiClemente, 1983; 1986; 1992) is a general model of intentional behavior change. Originally, it was developed to explain changes in addictive behaviors, but has since been widely used to explain various health-related behaviors, such as exercise (e.g., Gorely & Gordon, 2005). The model illustrates the dynamic nature of behavior change and establishes that behavior change is likely to take place through a series of stages. However, instead of a linear progression, the change can be cyclical with progression and relapses between the stages (Gorely & Gordon, 2005; Prochaska & DiClemente, 1992).

The model presents three hierarchical levels that are integrated to produce behavior change: 1) five stages of change, 2) three factors assumed to influence behavior change, and 3) the context of the behavior (Gorely & Gordon, 2005; Prochaska & DiClemente, 1986). The five stages of change include Precontemplation, Contemplation, Preparation, Action, and Maintenance. The three factors assumed to influence behavior change include the processes of change, self-efficacy, and decisional balance. The context of the behavior identifies the central issue that the individual needs to overcome in order to change the behavior in question (Gorely & Gordon, 2005; Prochaska & DiClemente, 1986). The present study focuses on the five stages of change and the self-efficacy factor, which is a central determinant of exercise behavior.

Prochaska and DiClemente (1992, p. 1103–1104) define the five stages: 1) *Precontemplation,* "at which there is no intention to change behavior in the foreseeable future"; 2) *Contemplation*, "in which people are aware that a problem exists and are seriously thinking about overcoming it but have not yet made a commitment to take action"; 3) *Preparation*, "that combines intention and behavioral criteria" and in which individuals "are intending to take action in the next month and have unsuccessfully taken action in the past year"; 4) *Action*, "in which individuals modify their behavior, experiences, or environment in order to overcome their problems"; and 5) *Maintenance*, "in which people work to prevent relapse and consolidate the gains attained during action". These stages have been shown to apply also in the case of exercise and aged people (e.g., Gorely & Gordon, 2005) and are, thus, well suited to illustrate the behavior change process investigated in the present study.

2.3 Self-efficacy

Self-efficacy refers to an individual's "belief in one's capabilities to organize and execute the courses of action required to produce given attainments" or, in other words, "the belief that one can achieve what one sets out to do" (Bandura, 1977, 1997). Bandura (1977) presents four central sources that influence an individual's self-efficacy: 1) *performance accomplishments* refer to experiences an individual gains when undertaking a new task and successfully mastering it; 2) *vicarious experience* refers to an experience of observing other individuals successfully complete a task without adverse outcomes; 3) *verbal persuasion* refers to external positive verbal feedback regarding an individual's ability to succeed in a task; and 4) *emotional arousal* refers to an individual's present state of arousal and how that influences the perceptions of being able to succeed in a task (Bandura, 1977). It is important to note that all these four main sources of influence can have either a positive or a negative influence on self-efficacy. For example, if an individual fails in a task, it can decrease self-efficacy (Bandura, 1977). Of these four, performance accomplishments have repeatedly been shown to be the most influential (McAuley & Blissmer, 2000).

Self-efficacy has a significant influence on human behavior and on individuals' actions. A person with high self-efficacy is more likely to undertake tasks that one perceives as challenging, whereas a person with low self-efficacy is more likely to avoid such tasks (Bandura, 1977; Schunk, 1990). Moreover, individuals with high self-efficacy are likely to be more successful than individuals with low self-efficacy (Bandura, 1997). This also applies in the case of exercise (McAuley & Blissmer, 2000). Indeed, self-efficacy has been shown to be one of the most important determinants of exercise behavior (Bauman et al., 2012; Trost et al., 2002; Warner et al., 2014). It has an important role in both the adoption and adherence phases of exercise: after initial mastery experiences, self-efficacy supports maintaining health-related behaviors, and helps in resuming them if facing challenges (Warner et al., 2014). Self-efficacy has been demonstrated to be a significant predictor of long-term exercise adherence (McAuley & Blissmer, 2000; Warner et al., 2014; Williams & French, 2011). This applies also among aged people (King et al., 1995; McAuley, 1993; McAuley et al., 2005). Furthermore, self-efficacy has been shown to increase as an individual moves through the stages of exercise behavior change (Marcus et al., 1992).

3 Methodology

3.1 Research setting

The present study was part of the *DigitalWells* research program, in which aged people were provided with a mobile physical activity application to use in their everyday life. The application was developed for the target group in the program and operates on the Wellmo platform (Wellmo, 2021), where the application features constitute their own entity. Wellmo supports the iOS and Android operating systems. The central features are related to tracking everyday PA and exercise. This includes, for example, features for tracking the conducted PA and exercises as well as weekly, monthly, and annual reports on these. It is also possible to import data from external services supported by the Wellmo platform, such as Google Fit, Apple Health, and Polar Flow.

The first groups of participants in the research program started in June 2019, after which new groups started continuously. The program and the present study were conducted in Finland, and the groups were recruited via the Finnish pensioners' associations. No limits except for age were set for partaking. Each group was assigned a researcher who guided the participants in taking the application into use and using it. The participants used the application in their everyday life and conducted PA and exercise according to their preferences. That is, they were not provided with any specific exercise programs to follow, but instead could freely conduct exercise how and when they preferred. The application use was free of charge for the participants, but an own smartphone was required. The local ethical committee was consulted before the start of the research program, which deemed that no separate approval was required for the conducted studies. All participants also gave a written informed consent.

3.2 Data collection and analysis

The data on the stages of exercise behavior change and self-efficacy for exercise were collected as a self-report with online surveys at two different time points: at the beginning of the program before taking the application into use (t0) and after 12 months of partaking in the program and using the application (t1). Thus, the participants in the present study consist of those partaking in the research program and using the application for at least 12 months. For the surveys, each participant received a survey invitation link via email, and they were also provided with instructions on answering. No interim results of the analysis were presented to the participants during the study period.

The stages of change were measured by using the Stage of (exercise behavior) Change Instrument (Gorely & Gordon, 2005; Marcus et al., 1992). It places individuals into either Precontemplation, Contemplation, Preparation, Action, or Maintenance stage (Appendix A). Self-efficacy was measured by using the Self-Efficacy for Exercise (SEE) Scale by Resnick and Jenkins (2000), which assesses an individual's beliefs in their ability to exercise three times per week for 20 minutes. The SEE scale includes nine statements concerning personal confidence related to conducting exercise (Appendix B), measured on a scale of 0–10 (0 - *not confident* – 10 - *very confident*). The SEE scale also includes a total score value (0–90), which represents the overall self-efficacy for exercise. It is calculated as a sum of the responses to each statement, with a higher score indicating higher self-efficacy (Resnick & Jenkins, 2000). In the present study, this self-efficacy total score was used to represent participants' self-efficacy level. The SEE scale is widely used in measuring self-efficacy for exercise, and it has been tested to be reliable and valid also in the case of older adults (Resnick & Jenkins, 2000). Both scale questionnaires were translated from English to Finnish and Swedish, which are the two official languages of Finland.

To analyze the participants' *changes in the stages of exercise behavior change*, the stages of change between baseline t0 and follow-up t1 were examined. More specifically, the statistical significance of the changes in the stages of change was analyzed with the McNemar-Bowker test (Bowker, 1948). The missing values were handled by excluding the responses of a particular participant if the participant had not responded to the stage of change question in both t0 and t1. To examine if self-efficacy for exercise could differentiate the program participants in terms of the stages of change, a one-way analysis of variance (ANOVA) test was performed, followed by post-hoc comparisons by using the Tukey-Kramer test (Kramer, 1956). The total self-efficacy scores were included only from those participants who had responded to all the self-efficacy statements in t0 and t1 (i.e., their self-efficacy total score was based on responses to all the nine statements). The collected data were analyzed with the IBM SPSS Statistics 26 software, and the threshold of statistical significance was set to $p < 0.05$ for all the tests.

4 Results

In total, 320 participants responded to the stage of change question at both t0 and t1 and were, thus, eligible to be included in the sample of the present study. Descriptive statistics of these 320 participants are reported in Table 1.

Table 1: Descriptive statistics of the sample of the study (N = 320)

	n	%
Gender		
Female	197	61.6
Male	123	38.4
Other	0	0.0
Age (mean 70.0 years, SD 4.3 years)		
–64 years	25	7.9
65–69 years	112	35.2
70–74 years	140	44.0
75– years	41	12.9
N/A	2	–
Highest education		
Primary education	45	14.1
Vocational education	207	64.7
University of applied sciences	16	5.0
University	44	13.8
Other	8	2.5
Marital status		
Married	218	68.8
Common-law marriage	31	9.8
Single, divorced, or widow/er	68	21.5
N/A	3	–

4.1 Stages of change categories

The changes in the stages of change were examined through the number and proportion of participants at the five different stage categories between t0 and t1 (Table 2). More precisely, it was examined how many had moved up, moved down, or stayed at the same stage category (Table 3).

Of the participants, none were at the Precontemplation stage at t0, which could be expected considering that they had just joined a digital wellness program. One participant (0.3%) was at the Contemplation stage, 45 (14.1%) were at the Preparation stage, 57 (17.8%) were at the Action stage, and 217 (67.8%) were already at the Maintenance stage. At t1, three participants (0.9%) were at the Contemplation stage (they could, for example, have had a health issue preventing them from conducting exercise), 30 (9.4%) were at the Preparation stage, 37 (11.6%) were at the Action stage, and 250 (78.1%) were in the Maintenance stage (Table 2). Thus, the number of those at the Maintenance stage had increased from 217 to 250 (a 15.2% increase) between t0 and t1. Respectively, the number of those initially at the Contemplation, Preparation, or Action stage had decreased from 103 to 70 (a 32.0% decrease). Further, the number of those initially at either the Contemplation or the Preparation stage had decreased from 46 to 33 (a 28.3% decrease) (Table 2).

Table 2: Proportion of participants at different stages at t0 and t1 (N = 320)

	t0		**t1**	
Stage of change	**n**	**%**	**n**	**%**
Precontemplation	0	0.0	0	0.0
Contemplation	1	0.3	3	0.9
Preparation	45	14.1	30	9.4
Action	57	17.8	37	11.6
Maintenance	217	67.8	250	78.1

Overall, after 12 months (t1), 66 (20.6%) of the participants had moved up, 31 (9.7%) had lowered down, and 223 (69.7%) were at the same stage (Table 3). The McNemar-Bowker test suggested that the overall change in stages of change was statistically significant ($\chi^2(6) = 20.166$, $p = 0.003$).

Table 3: Changes in participants' stages between t0 and t1 (N = 320)

Stage of change	**t1** Contemplation	**t1** Preparation	**t1** Action	**t1** Maintenance
t0 Contemplation	0	1	0	0
t0 Preparation	0	14	9	22
t0 Action	1	7	15	34
t0 Maintenance	2	8	13	194

Those 217 who were at the Maintenance stage at t0, seemingly were already exercising regularly, and those 57 at the Action stage, had started their change towards it. From an effectiveness perspective, supporting those at the Action stage to continue on their path towards the Maintenance stage is of course important, but even more so is the support for those at the Precontemplation, Contemplation, and Preparation stages. Therefore, it was further examined how those participants (n = 103) at the Contemplation, Preparation, or Action stages at t0 (none were at the Precontemplation stage) were able to change their behavior, that is, how their stage at t1 differed from their stage at t0. Overall, after 12 months, 66 (64.1%) of these 103 participants had moved up, 8 (7.8%) had lowered down, and 29 (28.2%) were at the same stage. Of these 103 participants, 56 (54.4%) had moved up to the Maintenance stage.

4.2 Self-efficacy as a differentiating factor

A one-way ANOVA test was performed to examine the relationship between the stage of change and self-efficacy for exercise total score, followed by post-hoc comparisons by using the Tukey-Kramer test to determine which stages the self-efficacy measure was able to differentiate. The Shapiro-Wilk (1965) test showed that the self-efficacy total score was not normally distributed in each category being compared, more specifically, in the Maintenance stage category at t0 and t1. However, the Levene's (1960) test for homogeneity of variances showed that the variances of self-efficacy in each category being compared were equal at both t0 and t1. Thus, as both ANOVA and the Tukey-Kramer test have been found to be robust against non-normality (Driscol, 1996), there were no obstacles for their application. To be able to run the analysis, the participants at the Contemplation stage (one at t0 and three at t1) were combined with the participants at the Preparation stage. Table

4 depicts the self-efficacy means and standard deviations (SD) for different stages of change.

Table 4: Self-efficacy for exercise total score for different stages of change (N = 265)

	t0		t1	
Stage of change	**n**	**mean (SD)**	**n**	**mean (SD)**
Contemplation + Preparation	35	48.5 (17.0)	24	41.3 (17.2)
Action	51	50.1 (13.9)	32	50.8 (13.8)
Maintenance	179	59.2 (17.5)	209	63.0 (17.0)
Whole sample	265	56.0 (17.3.)	265	59.6 (18.0)

The analysis revealed that the self-efficacy total score differentiated the participants at different stages at t0 ($F(2, 262) = 9.815$, $p < 0.001$). The Tukey-Kramer post-hoc test revealed that the participants at the Maintenance stage were significantly different from those at the other stages. There was no statistically significant difference between the participants at the Contemplation + Preparation and Action stages. Similarly, at t1, the self-efficacy score differentiated the participants at different stages ($F(2, 262) = 23.148$, $p < 0.001$). The result of the Tukey-Kramer post-hoc test was also similar: participants at the Maintenance stage significantly differed from those at the other stages but there was no statistically significant difference between the participants at the Contemplation + Preparation and Action stages.

5 Discussion

The main purpose of the present study was to investigate 1) how partaking in a digital wellness program influences the stage of exercise behavior change among aged people, and to test 2) whether self-efficacy for exercise can differentiate the program participants in terms of the stages of change. The results suggest that partaking in a digital wellness program can be effective in promoting exercise behavior change among aged people. In general, this finding is in line with previous research (e.g., Stockwell et al., 2019). There was a statistically significant overall change in the participants' stages of exercise behavior change, with participants rather moving to a higher than to a lower stage during the first 12 months in the program. Of those who were at the Contemplation, Preparation, or Action stages when joining the program, 64.1% moved to a higher stage and 54.4% to the Maintenance stage (they exercised regularly and had done so for longer than 6 months). As the Maintenance stage is the preferred stage of exercise, this observed change from the lower stages to the Maintenance stage is highly valuable from the effectiveness perspective. However, as suggested by Gorely and Gordon (2005) and to some extent by the results of the present study, relapses can take place. Thus, it is also important to continue providing support for those at the Maintenance stage.

Considering the key role of the physical activity application use in the program and the findings from previous studies (e.g., Stockwell et al., 2019), it seems plausible that these kinds of DWTs can work as BCSSs (Oinas-Kukkonen, 2013) for aged people. This likely applies both when utilized as a part of digital wellness programs and also without one, as in the present program, the participants did not have active exercise programs or counseling. However, what warrants further investigation is which application or BCSS features are particularly effective for aged people at different stages of change, as research has shown that the stage of change can have a significant role in the perceived persuasiveness of different strategies (Oyebode et al., 2021).

The results also show that self-efficacy for exercise may differentiate aged people at different stages of exercise behavior change. More precisely, those at the Maintenance stage seem to have a significantly higher self-efficacy for exercise than those at the lower stages. This is in line with previous research (e.g., Kuroda et al., 2012; Marcus et al., 1992). While the purpose of the present study was not to investigate the influences on self-efficacy for exercise, we believe that the physical activity application use could have influenced the self-efficacy levels as, for example, actions like exercise tracking and graphical review of the data can lead to performance accomplishments (Bandura, 1977).

The present study also provides some practical insights for those stakeholders working with PA and exercise promotion. First, digital wellness programs utilizing physical activity applications, or other BCSSs, seem to be potential in supporting PA and exercise behavior change. Thus, deploying such programs could be a good way to increase the PA and exercise levels of aged people. Second, as the participants at the Maintenance stage had a significantly higher self-efficacy for exercise compared to those at the lower stages, digital wellness programs should aim to increase their participants' self-efficacy for exercise to a level matching those at the Maintenance stage. This would be highly valuable for long-term exercise adherence and, subsequently, also for healthier ageing.

6 Limitation and future research

This study has some limitations that should be acknowledged. First, due to the lack of a control group, the possible influence of extraneous variables on the results cannot be ruled out. Second, compared to the aged population in general, the sample seemed to represent a more physically active segment, as about two-thirds were at the Maintenance stage already at t0. This might have limited the size of the changes in stages of change. Future research should aim to recruit more participants also from the lower stages of change. Third, the possible influence of the COVID-19 pandemic cannot be ruled out as the restrictions, such as temporal closures of various exercise facilities and breaks in many group activities may have had a negative influence on some participants' stage of change or self-efficacy for exercise. Hence, future research could replicate the study after the pandemic and in other countries. Future research could also focus on investigating the direct relationship between self-efficacy for exercise and the stages of change in order to examine whether the changes in self-efficacy lead to changes in stages of change and how big a change is needed for that. Additionally, as longitudinal research is much called for, we encourage scholars to invest in studying how DWTs can be further utilized to support PA and exercise behavior change among aged people.

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Appendices

Appendix A. Stage of (exercise behavior) Change Instrument (Gorely & Gordon, 1995; Marcus et al., 1992)

Which of the following statements best applies to you at the moment:

- Do not currently exercise and are not seriously thinking about changing for the next 6 months. (Representing **Precontemplation**)
- Do not currently exercise but are seriously thinking of starting in the next 6 months. (Representing **Contemplation**)
- Exercise some but not regularly. (Representing **Preparation**)
- Have started to exercise regularly (a minimum of 3 sessions of at least 20 minutes per week) in the last 6 months. (Representing **Action**)
- Exercise regularly and have done so for longer than 6 months. (Representing **Maintenance**)

Appendix B. Self-efficacy for Exercise Scale statements (Resnick & Jenkins, 2000)

How confident (on a scale of 0–10) are you right now that you could exercise three times per week for 20 minutes if:

1. The weather was bothering you
2. You were bored by the program or activity
3. You felt pain when exercising
4. You had to exercise alone
5. You did not enjoy it
6. You were too busy with other activities
7. You felt tired
8. You felt stressed

You felt depressed