Using Sport and Wellness Technology to Promote Physical Activity: An Intervention Study among Teenagers

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Abstract

Life-long physical activity patterns are established during teenage years. Thus, promoting physical activity for teenagers is important. Sport and wellness technology shows promise for promoting physical activity. Yet, its research with teenage populations is sparse. This intervention study focused on whether using a sport and wellness technology application could affect the physical activity intention of teenagers, its antecedents, and the antecedents' effects on intention by using the theory of planned behavior combined with the concept of self-efficacy as a theoretical framework. The results showed no statistically significant difference between the intervention and the control group in terms of the means and variances of the four constructs in our theoretical model. However, we found a statistically significant difference in the effect of self-efficacy on intention in the intervention group. The results show potential in using sport and wellness technology in physical activity interventions for teenagers. However, further research is needed.

1. Introduction

According to the World Health Organization, over 80% of world's adolescent population is not physically active enough. What makes the situation even worse is the steadily decreasing trend of physical activity and the steadily increasing trend of sedentary behavior of this population [1,2]. Today's teenagers live in an environment that offers them an increasing number of options for sedentary leisure activities as well as an increasing number of barriers to physical activity.

Health related behavioral patterns concerning, for example, physical activity, sleep, and nutrition are being established during the teenage years, and these learned patterns are usually maintained throughout life [3]. Thus, promoting healthy behaviors, such as physical activity, during the teenage years has an important impact on the overall life quality of a person. Enabling exercise participation and promoting physical activity has the ability to foster personal competence and improvement. This, in turn, will help teenagers to achieve personal goals regarding their physical activity intentions and is important for the formation and maintenance of long-term health behaviors [4].

Today, technology plays a major role in teenagers' lives because many of them are constantly online and use various applications and devices on a daily basis. Thus, it is reasonable to consider also using technology in health and physical activity promotion and interventions. For example, the role of sport and wellness technology devices and applications in health promotion should be highlighted. Most of the current sport and wellness technology applications and devices, such as wearable devices, have been designed for adults who are already physically active and want to maintain their active lifestyle or improve their performance level [5]. Teenagers associate the need of wearable sport and wellness technology devices with serious goals and a strong aim for achieving them [6].

There is a gap in research related to teenagers and their use of internet, mobile applications, and wearable fitness devices for health-related purposes [7]. There are few wearables created especially for teenagers, but these devices have focused on game related elements and connectivity [6]. Understanding what kinds of effects sport and wellness technology has on teenagers is relevant for the sport technology companies to be able to create products and services that not only attract this target group but are also effective and useful.

The use of interactive technology might increase the appeal of physical activity related interventions [8]. However, there is a lack of empirical evidence supporting the effectiveness of these targeted health behavior interventions and how sport and wellness technology can stimulate health behavior change in younger populations [9]. When designing intervention programs, understanding what motivates young people to participate in physical activity is essential [10]. The

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focus should be on strategies that include psychosocial issues, sport competence and physical self-worth [9].

This paper reports the findings from a five-week-long intervention study that was conducted to increase the knowledge about sport and wellness technology and its effects on the physical activity of teenagers. More specifically, the aim was to find out from IS and exercise psychology perspective whether the use of a sport and wellness technology application could affect the physical activity intention of teenagers, its antecedents, as well as the effects of these antecedents on intention by using the theory of planned behavior (TPB) combined with the concept of self-efficacy as a theoretical framework. The study, which followed a quantitative approach, included 64 teenagers divided into an intervention group and a control group, of which the intervention group was provided with a sport and wellness technology application for the five-week intervention period. The study also aimed to encourage future research regarding sport and wellness technology, teenagers, and their physical activity, particularly from a sports psychological point of view.

2. Theoretical model

The theoretical model of the study is based on the Theory of Planned Behavior (TPB) by Ajzen [11,12], which is an extension of the Theory of Reasoned Action (TRA) [13,14]. According to the TPB, an individual's stated intention to perform a certain behavior in a given time and context is a proximal predictor of behavior. This intention is a function of a person's attitude, subjective norm, and perceived behavioral control (PBC). Attitude is based on individual's perceptions of the intended behavior and his/her evaluation of the behavior outcome. Subjective norm refers to a person's estimate of the extent that other important people to them would like the person to engage in that behavior. PBC refers to a person's perception of his/her abilities and the limiting facilitating factors related to the intended behavior, such as barriers to access. The TPB differs from the TRA by including PBC as a behavioral antecedent. TPB has often been used in studies about intentional behavior [4], such as in physical activity related studies with adults [15,16] and young people [4,17,18]. According to these studies, attitude and PBC tend to be the most important antecedents of physical activity intention. However, in the case of young people, the importance of subjective norm is higher [4].

In the social cognitive theory, Bandura [19] introduced the concept of self-efficacy, which refers to a person's beliefs in his/her capabilities of performing a specific task. Self-efficacy is not about the person's skills but rather a person's judgements regarding what he/she can do with these skills. People with high levels of self-efficacy are more likely to perceive difficult tasks as challenges and, therefore, perform better, whereas people with low levels of self-efficacy might avoid doing tasks which they perceive being difficult. Self-efficacy also relates to motivation. If a task is perceived too difficult or too easy compared to one's own skills, motivation to continue can decrease. Conversely, tasks that are perceived moderately difficult and challenging can produce the experience of achievement, thus bringing satisfaction [20]. Self-efficacy can influence also health-related behavior, including physical activity and exercise [21].

According to [19], there are four different sources of information affecting the person's self-efficacy: performance accomplishments, vicarious experience, verbal persuasion, and physiological states. Performance accomplishments are based on mastery experiences, and they are the most powerful source of self-efficacy. Vicarious experiences means experiences received through observing other people. Verbal persuasion means comments and feedback heard from other people. Finally, physiological states refers to the perceived emotional arousal, such as stress, experienced in a specific situation.

The concept of self-efficacy was integrated to the TPB in 1991 [12]. Self-efficacy has been closely associated with PBC, explaining the internal perceptions regarding personal abilities but leaving out the limiting facilitating factors. Dividing PBC into two parts, internal and external, has been recommended [22], proposing that self-efficacy reflects the internal aspects of control, such as the abilities to perform physical activity, and that PBC refers to the external aspects of control, such as the barriers for performing physical activity. Another conceptualization of PBC is presented by Fishbein and Ajzen [23] who divide it into two dimensions referred to as capacity and autonomy. Of these, capacity refers to the perception that one can, is able to, or is capable of performing the behavior and thus is comparable to self-efficacy. In contrast, autonomy refers to the perceived degree of control over performing the behavior. However, in some studies, the terms PBC and self-efficacy have been used interchangeably [24].

As a basis of our theoretical model, we use the study by Hagger et al. [4], which used the TPB, combined with the concept of self-efficacy, to explain the exercise intentions of teenagers. However, in contrast to the present study, this prior study was not conducted as an intervention study but as a cross-sectional survey study. We deviate from this theoretical model used by [4] as follows: Due to the considerable conceptual overlap of the two constructs as discussed above, we chose to include only self-efficacy and not PBC into our theoretical model. The theoretical model, in which intention (INT) is explained by attitude (ATT), subjective norm (SN), and self-efficacy (SE), is illustrated in Figure 1.

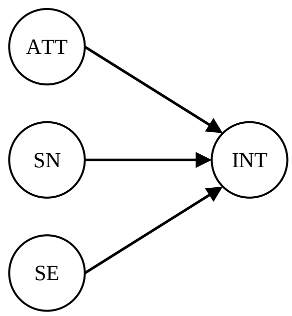

Figure 1. Theoretical model of the study

The importance of attitude and self-efficacy related to exercise intentions is also highlighted in a study by [24]. Furthermore, intention and self-efficacy have been found to be the two strongest predictors regarding physical activity behavior of teenagers [25].

3. Methodology

3.1. Study design and data collection

This study followed a quantitative approach. The study was done in Finland and included 64 teenage participants of whom 34 were girls and 30 were boys. The age group was between 13 to 15 years old. The participants were divided into two groups. The intervention group consisted of 34 participants (18 girls, 16 boys) and the control group consisted of 30 participants (16 girls, 14 boys). The participants were recruited from three local junior high schools with the help of the school teachers. The intervention group participants were recruited from two schools and the control group participants from a third school, in order the groups to not know about the existence of the other group. All the students who expressed their interest were selected to the study regardless of their physical activity background. In Finland the physical activity recommendation for teenagers (ages 12–18) is 1–1,5 hours per day [26]. In both groups, around 20% of the participants self-reported not reaching the requirements on average. In the introduction phase, both groups were told the topic of the study was related to physical activity and exercise motivation. All the participants had a signed approval from their parents. The data was collected during winter 2017-2018 in two phases. In the beginning and end of the five-week intervention the participants filled out a questionnaire about their perceptions regarding their own exercising and physical activity. The questionnaire used in the study was the same originally used by [4]. To ensure the participants' level of understanding, the questionnaire was translated into Finnish. The translation was tested using academic representatives and representative of the target group's demographic.

Like our theoretical model, also the measurement of the model constructs was based on the prior study by [4]. In accordance with it, intention, attitude, and self-efficacy were each measured by using a reflective measurement model with three indicators. In contrast, subjective norm was measured by only one indicator, which is "quite common and consistent with TPB" [27] although it obviously makes it impossible to statistically control the potential measurement error. The seven indicators that were measuring intention, attitude, and subjective norm were originally adapted from the reasoned action approach [23], whereas the three indicators that were measuring self-efficacy were developed in the prior study by [4] and applied from it. All the indicator wordings are reported in Table 1. The measurement scale of subjective norm and intention was a seven-point Likert scale, whereas the measurement scale of attitude was a seven-point semantic differential scale. In turn, the measurement scale of self-efficacy was a 10-point confidence scale ranging from 0 % to 100 %.

Table 1. Indicator wordings

Item	Wording
INT1	I intend to participate in physical activities that make me out of breath at least three times during my free time in the next week.
INT2	I plan to participate in physical activities that make me out of breath at least three times during my free time in the next week.
INT3	I will participate in physical activities that make me out of breath at least three times during my free time in the next week.
ATT1	Doing physical activities that make me out of breath at least three times in a week is bad vs. good.
ATT2	Doing physical activities that make me out of breath at least three times in a week is boring vs. exiting.
ATT3	Doing physical activities that make me out of breath at least three times in a week is unpleasant vs. fun.
SN	Most people important to me think I should do physical activities that make me out of breath at least three times in a week.
SE1	How confident are you in doing physical activities that make you out of breath at least three times in the next week when you are going out with your friends?
SE2	How confident are you in doing physical activities that make you out of breath at least three times in the next week when the weather is bad?
SE3	How confident are you in doing physical activities that make you out of breath at least three times in the next week when you have homework to do?

After the first round of questionnaires were finished, all the participants in the intervention group downloaded and installed a free sport and wellness technology application which they were asked to use for the next five weeks in a way most suitable for them. The aim of the study was not to intentionally try to increase the level of physical activity of the target group rather to see whether using a sport and wellness technology application has an impact on their exercise intention from an exercise psychology point of view. Therefore, the use of the application was not controlled or observed during the intervention period and no extra promotion regarding physical activity was performed by the researchers or the teachers. Whereas the control group continued their physical activity habits as before, all the students in the intervention group reported to have been using the activity tracker during the intervention period in the most suitable way for them. In both the control and intervention groups, the level of participants' physical activity varied from almost sedentary to an athletic level. In the beginning of the study, most of the participants in both groups reported being somewhat familiar with sport and wellness technology, though for most of them, prior experience was restricted only to occasional usage.

The sport and wellness technology application used in this study was called Sports Tracker of which we used the premium version as it is add-free [28]. Sports Tracker is a fitness app for smartphones. The app functions as a workout tracking application, training log, and social media platform for its users. The application was suitable for the study since it consisted of basic tracking functions as well as the opportunity to be used in a Finnish language. The application can be used with various sports and activities. These elements were suitable for the target group.

After the intervention period, the intervention group participants were asked about their application usage. Most participants reported using the workout tracking and training log features whereas the social media sharing was not used by most participants.

3.2. Data analysis

The collected data was analyzed by using structural equation modelling. Since we were using data collected from two instead of only one point in time, we followed an approach suggested by Roemer [29], in which the model constructs were operationalized as change constructs that capture the potential change in their values between the two surveys. The indicators of these constructs were formed by subtracting the value of the specific indicator in the first survey from the value of that same indicator in the second survey.

Because of the small sample size, we used partial least squares (PLS) in estimating the models. However, by following the rough "ten times rule of thumb" [30, 31], which suggests a minimum sample size of ten times the largest number of indicators used to measure a construct with a formative measurement model or ten times the largest number of structural paths directed at a specific construct in the structural model, the sample size can still be considered as large enough in order to estimate separate models for the intervention group and the control group.

The model estimation was done with the SmartPLS 3.2.7 software [32] and by following the guidelines given by Hair et al. [33] for running the analyses and reporting the results in the IS context. For example, in the model estimation, we used path weighting as the weighting scheme and +1 as the initial weights, while the statistical significance of the model estimates was tested by using bootstrapping with 2,500 subsamples and individual sign changes. As the limit for statistical significance, we used $p < 0.05$. When estimating the models, all the constructs were specified as mode A [29] constructs measured by a reflective measurement model. Also, subjective norm was specified as a latent construct but measured by only single indicator whose loading and weight were fixed to one. Because of their low proportion, the missing values (about 2.1 % of all the values in the intervention group and about 2.4 % of all the values in the control group) were handled by using mean replacement.

The comparisons between the intervention group and the control group were based on first establishing an adequate level of measurement invariance by using the three-step MICOM (measurement invariance of composite models) procedure by Henseler et al. [34]. More specifically, the MICOM procedure posits that both configural and compositional invariance have to hold across the groups before any tests concerning the equality of their construct means, construct variances, and path coefficients can be meaningfully conducted.

4. Results

We will first report the results of model estimation as well as the evaluations of model reliability and validity separately for both the intervention group and the control group. After this, we will report the results of the group comparisons in terms of construct means, construct variances, and path coefficients.

4.1. Model estimation

Figure 2 reports the results of model estimation in terms of standardized path coefficients, their statistical significance, and the proportion of explained variance (R^2) for both the intervention group (left side) and the control group (right side). In both groups, the effects of attitude, subjective norm, and self-efficacy on intention were found as positive, but there were considerable differences in the effect sizes and statistical significance of the effects between the two groups. In the intervention group, both self-efficacy and attitude had a statistically significant effect on intention, and the model explained about 65.0 % of the variance in intention. In contrast, in the control group, all the effects were statistically not significant, and the model explained about 19.5 % of the variance in intention.

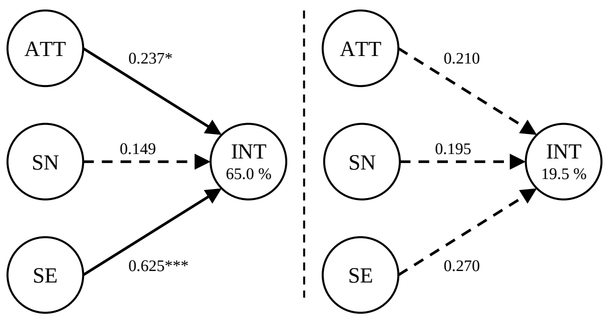

Figure 2. Results of model estimation (left = intervention group, right = control group, *** = p < 0.001, ** = p < 0.01, * = p < 0.05)

4.2. Reliability, validity, and goodness-of-fit

The reliability and validity of the estimated models for both the groups were evaluated at the indicator and construct levels. Indicator reliabilities and validities were evaluated by using the standardized loadings of the indicators. In a typical case in which each indicator loads only on one construct, it is commonly expected that the standardized loading of each indicator should be statistically significant and greater than or equal to 0.707 [35]. However, in some prior IS studies, even standardized loadings of as low as 0.4 have been seen as acceptable [36]. In this study, as a compromise, we used the standardized loading of 0.6 as the criterion for acceptance. The standardized loadings of the indicators for both the groups are reported in Table 2, along with their mean and standard deviation (SD). As can be seen, the criterion was met by all the indicators.

Table 2. Indicator means, standard deviations (SD), and loadings (* = p < 0.001, ** = p < 0.01, * = p < 0.05, a = fixed to one)**

	Intervention group			Control group		
	Mean	**SD**	**Loading**	**Mean**	**SD**	**Loading**
INT1	-0.029	1.749	0.863^{***}	0.267	1.081	0.886^{***}
INT2	-0.206	1.789	0.881^{***}	0.233	1.073	0.853^{***}
INT3	-0.029	1.732	0.893^{***}	0.533	1.252	0.829^{***}
ATT1	0.118	0.769	0.776^{**}	-0.241	0.857	0.678^{**}
ATT2	-0.091	0.668	0.651^{**}	0.379	1.064	0.821^{**}
ATT3	0.091	0.668	0.878^{***}	-0.036	0.928	0.810^{***}
SN1	0.419	1.343	1.000^{a}	0.233	1.194	1.000^{a}
SE1	-0.636	2.772	0.891^{***}	-0.500	1.776	0.818^{***}
SE2	-0.212	2.280	0.845^{***}	-0.367	3.168	0.784^{***}
SE3	0.545	2.536	0.766^{***}	-0.241	2.873	0.872^{***}

Construct reliabilities were evaluated by checking that the composite reliability (CR) of each construct was greater than or equal to 0.7 [35, 37]. The CR of the constructs is reported in the first column of Table 3 for the intervention group and Table 4 for the control group. As shown, all the constructs met this criterion. Construct validities were evaluated by examining the convergent and discriminant validity of each construct by using the two criteria based on the average variance extracted (AVE) of the constructs, which refers to the average proportion of variance a construct explains in its indicators [33]. To have acceptable convergent validity, the first criterion requires that each construct have an AVE greater than or equal to 0.5, meaning that, on average, each construct should explain at least half of the variance of its indicators. The AVE of the constructs is reported in the second column of Table 3 for the intervention group and Table 4 for the control group. As shown, all the constructs met this criterion.

Table 3. Construct reliabilities (CR), average variances extracted (AVE), and construct correlations for the intervention group

	CR	AVE	INT	ATT	SN	SE
INT	0.911	0.773	0.879			
ATT	0.815	0.599	0.549	0.774		
SN	1.000	1.000	0.304	0.178	1.000	
SE	0.874	0.698	0.760	0.457	0.181	0.835

Table 4. Construct reliabilities (CR), average variances extracted (AVE), and construct correlations for the control group

	CR	AVE	INT	ATT	SN	SE
INT	0.892	0.733	0.856			
ATT	0.815	0.597	0.245	0.773		
SN	1.000	1.000	0.337	0.375	1.000	
SE	0.865	0.682	0.287	-0.140	0.235	0.826

In order to have acceptable discriminant validity, the second criterion requires that each construct should have a square root of AVE greater than or equal to its absolute correlation with the other constructs. This means that, on average, each construct should share at least an equal proportion of variance with its indicators than it shares with the other constructs. The square root of AVE of the constructs (on-diagonal cells) and the correlations between the constructs (off-diagonal cells) are reported in the remaining columns of Table 3 for the intervention group and Table 4 for the control group. As shown, all constructs also met this criterion.

In addition, we evaluated discriminant validity by examining the cross loadings of the indicators. Here, in both the groups, all the indicators were found to have the highest loadings on the constructs that they were intended to measure, thus offering further support for acceptable discriminant validity.

Finally, although not in the guidelines by [33] and perhaps more common in the case of models estimated with consistent partial least squares (PLSc) [38, 39] rather than with the traditional PLS, we also evaluated the goodness-of-fit of the estimated models for both the groups in line with Henseler et al. [40] by checking whether the standardized root mean square residual (SRMR) as well as the geodesic discrepancy d_G and the unweighted least squares discrepancy d_{ULS} [38] of the estimated models as well as the saturated models with freely estimated correlations between the constructs were within their 95 % confidence intervals obtained from the Bollen-Stine [41] bootstrapping. As this was found to be the case, we can conclude that the discrepancy indicated by the aforementioned fit indices between the empirical covariance matrices and the covariance matrices implied by the estimated models is quite likely to result from sampling error rather than from a bad fit with the estimated models and the data. Therefore, the estimated models should not be rejected. However, this conclusion should be taken with caution as the value of evaluating the goodness-of-fit in the case of PLS still remains an open question [31].

4.3. Group comparisons

As already discussed above, the group comparisons and the investigation of measurement invariance were based on the three-step MICOM procedure [34]. First, configural invariance between the groups was found to hold because both groups employed an identical set of indicators to measure the constructs. In addition, the data treatment and the algorithm settings in both groups were identical.

Second, compositional invariance was assessed by examining whether the indicator weights estimated for the two groups are equal. One way to do this is through testing whether the correlation of the composite scores calculated for each study participant by using the indicator weights estimated for the intervention group with the composite scores calculated for the each study participant by using the indicator weights estimated for the control group ($c = \mathrm{cor}(\xi^{\mathrm{Intervention}}, \xi^{\mathrm{Control}})$) is equal to one. As a statistical test for this, we used a permutation test with 5,000 permutations [34]. The results of these tests in terms of the test statistic c, the 95 % confidence interval (CI) of the test statistic c, as well as the p value of the null hypothesis c = 1 are reported in Table 5. As can be seen, compositional invariance between the two groups was found to hold for all the constructs. Thus, the construct scores of the study participants can also be calculated by using the indicator weights estimated for the pooled sample instead of using the indicator weights estimated separately for each group.

Table 5. Testing compositional invariance

	c	95 % CI of c	p (c = 1)
INT	0.987	[0.986, 1.000]	0.051
ATT	0.917	[0.521, 1.000]	0.533
SN	1.000	[1.000, 1.000]	1.000
SE	0.996	[0.917, 1.000]	0.766

Third, the equivalence of the means and variances of the constructs was assessed by first calculating the construct scores of each study participant by using the indicator weights estimated for the pooled sample and then testing whether the difference in mean of the construct scores calculated for the intervention group and the mean of the construct scores calculated for the control group ($m = \mathrm{mean}\ \xi^{\mathrm{Intervention}} - \mathrm{mean}\ \xi^{\mathrm{Control}}$) as well as the logarithm of the ratio of the variance of the construct scores calculated for the intervention group to the variance of the constructs scores calculated for the control group ($v = \log(\mathrm{var}\ \xi^{\mathrm{Intervention}} / \mathrm{var}\ \xi^{\mathrm{Control}})$) is zero. As a statistical test for this, we used the permutation test with 5,000 permutations [34]. The results of these tests in terms of the test statistics m and v, their 95 % confidence interval of the test statistics m and v, as well as the p value of the null hypotheses m = 0 and v = 0 are reported in Table 6 in the case of the equivalence of means and in Table 7 in the case of the equivalence of variances. As shown, in the case of all constructs, the 95 % confidence interval of both test statistics included zero, supporting the null hypothesis that there were no differences in the means or variances of any of the constructs between the groups.

Table 6. Testing the equality of construct means

	m	95 % CI of m	p (m = 0)
INT	-0.326	[-0.509, 0.478]	0.194
ATT	0.050	[-0.518, 0.482]	0.843
SN	0.148	[-0.471, 0.476]	0.565
SE	0.067	[-0.481, 0.490]	0.788

Table 7. Testing the equality of construct variances

	v	95 % CI of v	p (v = 0)
INT	0.901	[-0.983, 1.010]	0.079
ATT	-0.625	[-0.954, 1.044]	0.221
SN	0.239	[-0.859, 0.893]	0.601
SE	0.289	[-0.957, 0.990]	0.556

Finally, we tested the equivalence of the path coefficients. We used the bias corrected 95% confidence intervals according to [42] in line with the procedure proposed by Sarstedt et al. [43], in which it is checked whether the effect sizes estimated for the intervention group are within the corresponding 95% bias corrected confidence intervals of the control group and vice versa. If there is no overlap, this means that there is a statistically significant difference in the path coefficients between the two groups. The effect sizes and their 95% bias corrected confidence intervals (CI) for both groups are reported in Table 8. As shown, a statistically significant difference in the path coefficients was found only in the effect of self-efficacy on intention, which was found to be much stronger in the intervention group. We also replicated the analysis while using no sign changes in bootstrapping, but this did not change our results.

Table 8. Testing the equality of path coefficients

Effect	Group	Effect size	95 % CI
ATT → INT	Intervention	0.237	[0.013, 0.394]
ATT → INT	Control	0.210	[0.000, 0.377]
SN → INT	Intervention	0.149	[0.009, 0.334]
SN → INT	Control	0.195	[0.003, 0.512]
SE → INT	Intervention	0.625	[0.397, 0.801]
SE → INT	Control	0.270	[0.005, 0.553]

5. Discussion and conclusions

This study was a quantitative study focusing on the impact of using sport and wellness technology on teenagers and their physical activity. The study was conducted as a five-week-long intervention study including 64 teenage participants divided into an intervention group and a control group. The theoretical model of the study was based on the TPB combined with the concept of self-efficacy. The aim was to find whether a sport and wellness technology application can affect the constructs of the theoretical model and their interrelationships and subsequently influence the physical activity behavior of teenagers.

There were two main findings. First, we found no statistically significant differences between the two groups in terms of the means and variances of the four change constructs. This means that the average attitude, subjective norm, self-efficacy, and intention of the study participants towards exercising did not increase or decrease due to the intervention, and the intervention also did not increase or decrease the variance between the study participants in these respects. Second, we found no statistically significant differences between the groups in the effects of attitude and subjective norm on intention, but we did find a statistically significant difference in the effect of self-efficacy on intention. This effect was found to be considerably stronger in the intervention group than to the control group. This means that the intervention strengthened the causal relationship between self-efficacy and intention so that positive changes in self-efficacy were likely to result in positive changes also in intention, whereas negative changes in self-efficacy were likely to result in negative changes also in intention. In other words, although the intervention did not affect self-efficacy or intention itself, it seemed to moderate their relationship.

From a theoretical point of view, the findings suggest that the use of sport and wellness technology, with self-monitoring of behavior as an intervention tool, can promote the relationship between exercise self-efficacy and exercise intention. The results contribute to the previous research [4] highlighting the role of sport and wellness technology as a mediator between self-efficacy and intention. The sport and wellness technology application was able to activate cognitive mechanisms for the behavior. However, it seems that other significant determinants such as planning or environmental influences were not activated, which suggests that a basic physical activity tracker needs other supporting additional intervention techniques to be effective for teenagers.

Although the reason for the increased connection between self-efficacy and intention cannot be explained by the research data, from a practical point of view, by having a sport and wellness technology application, the teenagers had a chance to see their exercise performance through numeric data and follow their exercise routines. This could have increased their awareness regarding their own physical activity. As also highlighted by [4], exercise data can help teenagers get personal control over their exercising. Further, the information from the activity tracker, received via self-monitoring, may have affected the user’s self-efficacy, which relates to having increased or decreased intentions for physical activity. An association between exercise self-efficacy and self-regulation techniques, such as self-monitoring, has been found in previous research [44, 45]. The feeling of psychological capability (self-efficacy) is an important element in behavioral change processes [46].

However, it is important to note that there are other elements, such as physical capability, motivation, and social and physical opportunity that affect the intention and behavior.

Sport and wellness technology has been found to be able to affect the levels of physical intention among adults [47]. However, according to intervention research among teenagers by [48], activity trackers are not able to affect the physical activity levels in general but are able to affect participants who have more positive attitude towards physical activity. Other previous studies done among Finnish teenagers [e.g., 49,50,51,52] have also found potential in using sport and wellness technology among teenagers, although they have not focused on testing psychological determinants. Our results are in line with previous research showing that the use of sport and wellness technology in teenage targeted interventions has potential but the technology should be accompanied with other intervention tools. Since teenagers are an important target group, it is important to study the preferences of teenagers to make the physical activity interventions successful.

To summarize, based on our findings, adding a sport and wellness technology device or application to a physical activity intervention can increase the connection between self-efficacy and physical activity intentions. However, using activity tracking sport and wellness technology devices or applications is not necessarily enough to induce actual changes in the physical activity intentions or behavior. Therefore, based on our results, we suggest adding some additional motivational elements into the interventions to affect the exercise intention and behavior. We recommend adding motivational elements to basic activity trackers or using these devices along with other kinds of intervention tools such as a human or digital coach.

6. Limitations and future research

This study has a few notable limitations. First, the size of the study sample was relatively small with 64 participants. Regardless, strong statistical significance was found regarding self-efficacy and exercise intentions. In the future it would be valuable to do similar studies with a larger data set as well as combining and comparing the psychological data with actual physical activity data. Second, the intervention period was approximately five weeks; a relatively short period. This limits the findings to relatively short-term effects. Future similar studies should be conducted with a longer study duration. Third, the participants in this study self-reported to be more physically active (80 % meeting guidelines) than the general teenage population (40 % meeting guidelines) in Finland. However, in reality this difference might not be so big considering the known challenges of research participants intentionally reporting their behavior more positively than reality [53]. Still, this can affect the generalizability of the results.

The sport and wellness technology device used in this study was relatively simple, consisting only of elements related to basic exercise tracking. In the future, similar studies could be done with using more advanced devices or applications, for example, ones that include gamification [52,54] or exergaming [55] elements. Focus could also be in personalized instructions and feedback (e.g., digital coaching) elements as suggested by previous research done among teenagers in Finland [51,52]. These elements could make the sport and wellness technology more interesting for teenagers so that they would want to continue using them for longer, which could subsequently promote a healthier lifestyle. We suggest that future research should focus on determining which application-based interventions are the most effective in increasing positive feelings towards physical activity. Overall, the topic of sport and wellness technology related to teenagers continues to be an important topic of research.

7. References

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