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Experiences of Using Mobile Health Applications to Support Participation in Exercise

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Abstract: *With advancement of mobile technologies and wireless communication, many healthcare apps have been developed to promote habitual physical activity and facilitate health self-healthcare. However, studies examining the effectiveness of these mobile health (mHealth) apps in enhancing exercise adherence are insufficient. Thus, the aim of this study was to help development of mHealth apps for continuous participation of exercise participants. In this study, a total of 379 questionnaires were analyzed using SPSS 23.0 and AMOS 23.0 programs. First, there was a significant difference in internal motivation for participation motivation according to the use of mHealth apps. On the other hand, no difference was found between amotivation and external motivation. There was a significant difference between exercise commitment and exercise adherence. Exercise commitment of leisure sports club participants, in particular, influenced exercise adherence. However, the direct moderating effect of exercise commitment did not significantly affect exercise adherence. The use of mHealth apps did not show a moderating effect. The use of the mHealth apps might enhance exercise adherence of the study population. The content design of mHealth apps can be considered to improve exercise adherence in future research.*

Keywords: Mobile Healthcare Applications; Internal Motivation; Amotivation; External Motivation; Exercise Commitment; Exercise Adherence

1. Introduction

The ongoing involvement of technology in physical activity participation has become more active through use of mobile devices and technology. Use of, mobile Health(mHealth) technology, in particular, is on an exponential rise, and mHealth has ability to manage various aspects of health behavior modification, such as exercise adherence, exercise prescription, and diet and eating habit control [1]. Additionally, accumulating the volume of exercise within a mHealth app has the advantage of self-feedback [2]. Approximately 30% of smart phone users employ mHealth apps to manage their health [3]. In fact, mHealth application market has grown significantly [4].

Recently, wearable devices that connect with mHealth apps have also risen to the spotlight. Wearable devices equipped with advanced functions (as well as being miniature and light in weight), work to collect and store data of human movement. They also connect with mHealth apps allowing individuals to check and manage their health [5]. According to a previous study, the mHealth app allowed individuals to measure the number of steps, activity time, distance traveled, exercise, etc., and received a service recording the number of calories consumed by the food they ate. Also the mhealth apps digitize and stores data collected by human movement. Through this, by linking records such as exercise amount, calories, and heart rate, individuals can self-diagnose and manage their health [6]. The analysis of mHealth apps has recently been recognized as an important research issue with a number of studies being actively conducted on this topic [7]-[9]. In this study, the use of mHealth apps and the amount of physical activity were studied, and it was found that mHealth apps users increased the amount of physical activity [10,11]. In addition, as a study on mHealth apps, there were studies on smartphone

use motivation and use satisfaction [12,13], and there was also a study on college students' experience of using mHealth apps [14]. However, most of the research is limited to the analysis on the functioning and composition of mHealth app experiences, services, and design. As a result, research on the relationship between participation, motivation, exercise commitment, and exercise adherence on mHealth apps users are insufficient. Thus, it is necessary to study how the use of mHealth apps affects the Changes participation of participants involved in leisure sports.

Figure 1. Sample diagram for healthcare application (source : mobile application).

The motivation to participate in sports is divided into the following components: internal motivation, external motivation, and amotivation [15]. Internal motivation is an action taken to obtain internal pleasure and satisfaction of the physical activity. Amotivation refers to a state in which there is a lack of willingness to participate in exercise, with no relation to compensation or interest. External motivation is the drive to accomplish a specific purpose by an outside motivator, such as socializing with others [16]. Exercise commitment is a psychological structure of the desire to continue participating in a sport [17] with an attachment to that sport. In other words, commitment occurs when the participants' consciousness changes to have positive outlook on sports participation and achieves an optimal interaction with the sport [18]. In particular, the exercise commitment has a great influence on the duration of exercise for participants involved in the sport [19]. Finally, exercise adherence is the direct participation in physical activity, meaning steady participation without any interruption [20]. This exercise adherence is influenced by the individual, society, and the environment [21]. Sports commitment is important as a psychological variable in the relationship between sports participation, motivation, and exercise adherence [22]. Positive emotions such as pleasure or interest that you feel from participating in sports provide motivation to participate in sports. These motivations are also involved in exercise immersion [23]. Therefore we analyzed the relationship between the use of mHealth app, participation motivation, exercise commitment, and exercise continuity. The purpose of this study is to help the development of mHealth apps for continuous participation of leisure sports club participants.

2. Materials and Methods

2.1. Sampling Method

In this study, a survey was conducted through convenience sampling method of Sports training center participants (walking, mountain climbing, etc.) living in Saha-gu and Nam-gu Busan, Korea. All males and females aged 10 to 50 years were included. The purpose and content of the study were fully explained to these participants, after promising to provide gift products to students who wish to respond to the survey, and a survey in from of questionnaires was obtained with their consent. The individual characteristics of the study subjects are shown in [Table 1].

The mHealth app is divided into information provision type, body measurement type, and maintenance type. The information provision type is a function that provides life information and exercise methods based on data. The body measurement type is a function that measures and collects various biometric information using

a special sensor. The maintenance type is a function that provides the collected body and exercise information through an expert or mobile. In this study, an information provision type mHealth app that provides living information and exercise methods based on data was used [24].

Table 1. The individual characteristics of the study subjects (N=379)

Variables	Variables	(N=379)	%	means	sd
Sex	Male	175	46.2	1.54	0.499
	Female	204	53.8		
Age	10-19s	84	22.2	2.84	1.471
	20-29s	101	18.7		
	30-39s	63	11.6		
	40-49s	71	15.8		
	Over 50s	60	30.9		
Exercise during	6 months or less	129	34.0	2.62	1.321
	6 months-1years	42	11.1		
	1year-2years	52	13.7		
	Over 2years	156	41.2		
Exercise frequency (1 week)	1time	25	6.6	3.32	0.921
	2times	44	11.6		
	3times	94	24.8		
	over 4times	216	57.0		
Exercise Time (1 time)	1 hour or less	71	18.7	2.11	0.769
	Between 1 and 2hour	220	58.0		
	Between 2 and 3hour	65	17.2		
	More than 3hour	23	6.1		
Use of mHealth apps (Use more than 10 minutes a day)	Yes	117	30.9	1.69	0.463
	No	262	69.1		

2.2. Participation motivation

Participation motivation refers to the power to do exercise [15]. The measure of participation motivation used in this study was the sports participation motivation scale that was used in the study of Pelletier, Fortier, Vallerand, Tuson, Briere, & Blais [25]. The question of participation motivation consisted of three factors: internal motivation (9 questions), amotivation (3 questions), and external motivation (5 questions). A 5-point Likert scale was used to answer these questions (① strongly disagree, ② disagree, ③ usually, ④ agree, ⑤ strongly agree).

2.3. Exercise commitment

Exercise commitment refers to a psychological state that continuously determines or requires exercise participation [17]. For exercise commitment, ESCM (Expansion of the Sport Commitment Model) produced by Scanlan, Simons, Carpenter, Schmidt & Keeler [26] was used. There were 4 questions in total. A 5-point Likert scale was used to answer these questions (① strongly disagree, ② disagree, ③ usually, ④ agree, ⑤ strongly agree).

2.4. Exercise adherence

Exercise adherence is participating in sports and participating regularly without interruption [20]. The questionnaire used in the study of Choi Ung-cheol and Hong Jin-bae [27] was modified to fit the present

situation. There were 4 questions in total. A 5-point Likert scale was used to answer these questions (① strongly disagree, ② disagree, ③ usually, ④ agree, ⑤ strongly agree).

2.5. Statistical analysis

This study analyzed a total of 379 questionnaires. SPSS WIN 23.0 was used for frequency analysis, exploratory factor analysis, t-test, and correlation analysis. AMOS 23.0 was used for confirmatory factor analysis, structural equation modeling, and moderating effects. We performed an exploratory factor analysis to extract common factors for each question. The factor rotation method used Varimax, a right-angle rotation method. Factor extraction was set to an eigenvalue of 1.0 or more and a factor-loading value of 4 or more. We performed confirmatory factor analysis through exploratory factor analysis.

2.6. Exploratory factor analysis

For exploratory factor analysis, principal component analysis was used as the extraction method of the basic structure and Varimax method was performed as the factor rotation method. In addition, The Kaiser–Meyer–Olkin (KMO) test > 0.5 and the Bartlett test $p < 0.05$ were conducted to confirm whether the collected data were suitable for factor analysis. Reliability analysis was performed using Cronbach's α coefficient representing internal consistency the results are shown in Table 2.

Table 2. Validity and Reliability Analysis of Internal motivation, Amotivation, External motivation, Exercise commitment, and Exercise adherence.

Variable	Question	Factor loading	Eigen values	Cronbach's α
Internal motivation	It's fun to learn new moves	0.824	9.340	0.779
	I'm glad to know more about exercise	0.814		
	Because of the pleasures you feel while performing difficult movements	0.804		
	It's fun to learn new moves that you haven't tried	0.794		
	When you fall in love with exercise, you can feel the exhilarating pleasure	0.794		
	Because exercise gives you an interesting and enjoyable experience	0.767		
	I feel like I'm totally engaged in exercise	0.776		
	Because of the excitement you feel while exercising	0.745		
	Because of the satisfaction you experience in developing your motor skills	0.696		
Amotivation	I'm not sure why I exercise	0.857	3.463	0.910
	Exercising is no longer my job	0.846		
	I'm currently thinking about quitting the exercise	0.814		
External motivation	If you exercise well, you get recognition from people you know	0.862	1.749	0.944
	Exercise A good chance to make others	0.839		
	To show off my exercise ability	0.829		
	Exercise is a good way to keep good friends	0.774		
Exercise commitment	Watch article or TV about lifestyle program first	0.778	1.452	0.845
	I'm Imagine making a great exercise program	0.705		
	Efforts to Obtain Information on Living Leisure sports Programs	0.650		
	I'm a participate leisure sports program	0.577		
Exercise adherence	Continuing exercise even if you are tired	0.869	1.294	0.870
	Continue to participate in exercise even if you can't afford it	0.857		
	Continue to participate in exercise even if you do not have time	0.790		
	Continuing to participate in the exercise	0.758		

KMO = 0.917, Checking correlations between variables; Bartlett = 6225.539, Matrix of correlation coefficients used in factor analysis; Factor loading, A value indicating the correlation between factors and Variables in factor analysis; Eigen values, Extracted sum of squares loading; Cronbach's α, Reliability Index.

2.7. Confirmatory factor analysis

This study conducted a confirmatory factor analysis on the extracted participant motivation (3 factors), exercise commitment, and exercise adherence factors. The result can be regarded as being appropriate as X^2 = 725.523, df = 242, $p < 0.000$, CFI = 0.921, TLI = 0.910, IFI = 0.921, RMSEA = 0.073. The research hypothesis was verified by using the structural equation model to analyze the relationship among participation motivation, commitment, and adherence in all subjects. To analyze the difference according to the use of mHealth app, the moderating effect was analyzed using the pairwise parameter comparison method.

3. Results

3.1. Analysis of difference in internal motivation, amotivation, external motivation, exercise commitment, and exercise adherence according to the use of mHealth apps

The difference in internal motivation, amotivation, external motivation, exercise commitment, and exercise adherence of leisure sports club participants according to the use of the mHealth app is shown in Table 3. There was a significant difference in the internal motivation ($p < 0.005$) of the participation motivation, but there was no significant difference between the amotivation ($p < 0.929$) of participation motivation and the external motivation ($p < 0.320$). On the other hand, exercise commitment ($p < 0.000$) and exercise adherence ($p < 0.019$) showed a significant difference.

Table 3. Differences among Internal motivation, Amotivation, External motivation, Exercise commitment, and Exercise adherence according to use of mHealth app.

Variable	Use of mHealth apps(n=117)		None use of mHealth apps(n=262)		t	*p*
	M	SD	M	SD		
Internal motivation	3.878	0.7325	3.649	0.7225	2.840**	0.005
Amotivation	1.971	0.8322	1.979	0.7956	-0.091	0.929
External motivation	2.711	0.9791	2.605	0.8935	0.996	0.320
Exercise commitment	3.643	0.7430	3.300	0.7936	3.958***	0.000
Exercise adherence	3.826	0.7180	3.625	0.7920	2.358*	0.019

*p<0.05, **p<0.01, ***p<0.001, Use of mHealth apps, Leisure sports club participants using mHealth apps; None use of mHealth apps, Leisure sports club participants none using mHealth apps: M, Mean; SD, Standard deviation; t, Value of t-test; *p*, significance level.

3.2. Correlation Analysis of Each Factor

The correlation between independent and dependent variables in this study is shown in Table 4. Internal motivation, amotivation, and external motivation all correlated with exercise commitment and exercise adherence.

Table 4. Pearson's correlation coefficient analysis among Internal motivation, Amotivation, External motivation, Exercise commitment, and Exercise adherence.

Variables	1	2	3	4	5
Internal motivation	1				
Amotivation	0.250**	1			
External motivation	0.261**	0.261**	1		
Exercise commitment	0.620**	-0.192**	0.243**	1	
Exercise adherence	0.559**	-0.294**	0.109*	0.481**	1

*p<0.05, **p<0.01, ***p<0.001, The Pearson correlation coefficient showed a positive relationship for Internal motivation, Amotivation, External motivation, Exercise commitment, and Exercise adherence.

3.3. Causal Analysis of Exercise commitment on Exercise adherence

[Table 5] shows the effect of exercise commitment on exercise adherence. The effect of exercise commitment on exercise adherence was 0.667, which was significant.

Table 5. Path analysis of Exercise commitment on Exercise adherence Using mHealth Apps after adjusted confounding variables

Path	Estimate	S.E.	C.R.
Exercise commitment → Exercise adherence	0.667	0.086	10.029***

*p<0.05, **p<0.01, ***p<0.001, Estimate is a non-standardized value, and the C.R (Critical ratio) value must be $p < 0.05$ and 1.96 or more.

3.4. Analysis of Moderating Effect According to Use of mHealth Apps

The moderating effect according to mHealth apps usage was .028, which was lower than p. <05, indicating no significant difference. Table 6 shows that there is no difference in the control effect.

Table 6. Analysis of Moderating Effect of Exercise commitment on Exercise adherence Using mHealth apps after adjusted confounding variables

Path	Use of mHealth apps				None use of mHealth apps			
	Estimates	S.E	C.R	*p*	Estimates	S.E	C.R	*p*
Exercise commitment → Exercise adherence	.849	0.136	6.264***	0.000	0.866	0.087	9.939***	0.000

*p<0.05, **p<0.01, ***p<0.001, Estimate is a non-standardized value, and the C.R (Critical ratio) value must be $p < 0.05$ and 1.96 or more.

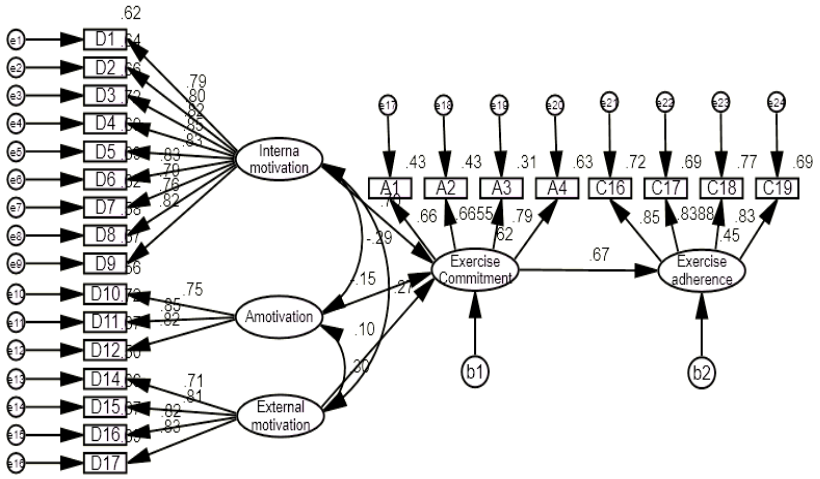

Figure 2. It is a Structural Equation Model. The effects of Internal motivation, Amotivation, and External motivation on Exercise commitment were analyzed in Participation motivation. Also, the effects of Internal motivation, Amotivation and Participation motivation on Exercise continuity were Analyzed.

4. Discussion

Physical activity has been globally recognized to have the key solution and prevention of increasing non communicable disease of lifestyle. Habitual physical activity is one of the major lifestyle-related health determinants, and sustainment of optimal exercise behavior is sentential in prevention NCDs [28]-[29]. Therefore, it is necessary to eliminate the decrease in exercise or the failure of exercise intervention and to continuously participate in exercise. The use of mHealth apps could be an alternative. This study analyzed the relationship between the use of mHealth apps, internal motivation, amotivation, external motivation, exercise commitment, and exercise adherence of leisure sports club participants. We confirmed that the use of mHealth

apps of leisure sports club participants had a positive effect on motivation to participate in exercise, exercise commitment, and exercise adherence.

The internal motivation of participation motivation was higher in the leisure sports club participants using the mHealth app. On the other hand, there was no difference between the amotivation and external motivation of participation motivation. In addition, exercise commitment and exercise adherence were higher in leisure sports club participants using the mHealth app. According to previous research People want to get useful health-related information through diverse media platforms (e.g., the internet, smart phones, etc.) [30]. In addition, many users of mHealth apps also used these applications to obtain health-related information. In particular, 50.3% of participants stated that their reason for using a mHealth app was because “I'm interested in healthcare” and 30.4% stated it was due to “Health care using healthcare application” [31], almost all of the participants use mHealth apps for their own health. , It can be inferred that people use mHealth apps to change their health behaviors (such as lifestyle changes and to increase exercise) [32]. The step measurement function of the mHealth app not only counts the number of steps, but also motivates the behavioral physical activity [33]. In other words, the use of mHealth app is highly associated to self-health. Thus, it can be an action towards obtaining inner pleasure and satisfaction [16]. In conclusion, checking physical activity through mHealth apps had an impact on the participation motivation of all participants. The use of sports apps is said to increase immersion by providing satisfaction to users [34]. In addition, the motivation for utilizing sports applications is an important variable in exercise commitment [35]. These sports applications influence the development and dissemination of various programs for participants involved in sports to concentrate on their exercise, ultimately contributing to suggest customized exercise activities for users [36]. The exercise participants in this study also showed high exercise commitment and exercise adherence.

This study was found that exercise commitment for participants involved in sports influenced exercise adherence. In most recent studies, conducted on exercise commitment and exercise adherence of participants involved in sports, exercise commitment has an effect on exercise duration [37]. Therefore, this study found that participants involved in sports had high exercise commitment and participation in sports.

There was no difference in the moderating effect of the use of a mHealth app in the effect of exercise commitment on exercise adherence. In result, it can be inferred that the use of a mHealth app does not influence control on the continuous participation in sports. In other words, it can be seen that steady exercise participants exercise without relying on mHealth apps. This is because, as users of the mHealth app, continuous sports participants are not devoting their time to using the mHealth app [38]. Specifically, mHealth app users have a deep interest in healthcare, but believe they are inefficient due to complex mobile functions [39]. In addition, the mHealth app is embedded with an individual's overall healthcare program (e.g., steps, calories burned, heart rate, etc.). This function can give useful information at the stage of starting exercise participation. In other words, for the function of the mobile health care application, it is necessary to consider the function of continuously monitoring and feedback the items of research results, not just reviewing the contents of exercise.

Not only mHealth app (eg, behavior change, fitness trackers) has become sophisticated, with continued development of technology bringing credibility to such devices. Continued research on the development of mHealth devices and ICT technologies could help to establish users' trust in the integration of technology (eg, mobile apps and wearable devices) to monitor health behaviors derived by exercise adherence and commitment. Future studies should explorer to the integration of a community group with access to a health-related self-monitoring app, and objectively measure self-monitoring in the living condition, to provide further understanding of the mechanism under which users are affected by mHealth scheme.

5. Conclusions

Causation cannot be inferred from cross-sectional study. Nevertheless, the success of certain healthcare interventions depends largely on participants’ adherence and commitment to encourage and prescribed exercise intervention regimes. Our findings highlight the role which personal factors and mHealth app features play in facilitating changes in thinking, including excitement; strategizing and motivation to support increased the habitual physical activity. Moreover, the use of the mobile health care application may be enhancing the exercise adherence and commitment of the study population. Further study is needed on intervention effectiveness and feasibility to explorer the usage of mHealth app and behavior change, and to develop valid and feasible exercise adherence and commitment assessment platform.

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