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Effect of a 12-week non-contact exercise intervention on body composition and health-related physical fitness in adults: a pilot test

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[Purpose] The purpose of this study was to evaluate the effects of a 12-week non-contact exercise intervention on body composition and health-related physical fitness in adults.

[Methods] One hundred adults were initially enrolled; however, ninety-seven participants (men: n = 41, women: n = 56) completed the study. The non-contact exercise was performed for 12 weeks using a smart tracker (Charge 4, Fitbit, USA) and mobile phone applications. The non-contact exercise program included resistance, aerobic, and flexibility exercises.

[Results] The results showed that percent body fat (F=4.993, p=.016, η_p^2=.049), fat-free mass (F=4.690, p=.024, η_p^2=.047), and skeletal muscle mass (F=5.623, p=.004, η_p^2=.055) significantly changed during the intervention period. Further, significant increases were seen in hand grip strength (F=12.167, p<.001, η_p^2=.112), sit-and-reach (F=20.497, p<.001, η_p^2=.176), sit-ups (F=42.107, p<.001, η_p^2=.305), and VO_{2max} (F=4.311, p=.037, η_p^2=.043).

[Conclusion] Our findings suggest that 12 weeks of non-contact exercise improves body composition and health-related physical fitness. Wearable technologies encourage individuals to modify their lifestyles by increasing physical activity and achieving the goal of maintaining health conditions among adults.

[Keywords] COVID-19 pandemic, non-contact exercise, wearable technologies, smart tracker, body composition, health-related physical fitness

INTRODUCTION

As the coronavirus disease 2019 (COVID-19) pandemic continues to develop in almost all regions of the world, the government has implemented various protective measures in response, including the closure of schools and universities, restrictions on travel and sporting events, and bans on social gatherings[1]. Individuals were ordered or advised to stay at home during the pandemic, with all these measures intended as effective strategies to prevent the spread of the virus and manage individuals infected with the virus[2]. While many individuals correctly followed official advice to self-quarantine and stay at home, these behaviors negatively affect their physical activity (PA) behavior and increase sitting time, and further affect well-being, sleep patterns, physical health, and quality of life[2]. The adverse effects of lack of PA on physical health are well established[3,4]. Implementing non-contact physical training programs during the pandemic, which can extend from weeks to months, can reduce the adverse physiological effects of sedentary behavior.

Digital healthcare technology has been developing rapidly in recent years, with various health-promoting equipment being developed. Owing to advances in industrial technology, wearable technology can provide new opportunities to motivate individuals to improve their PA levels, including mobile phone applications, smartwatches, wristbands, and other wearable devices[5]. Wearable technology refers to comfortable customer-based products with a simple and personalized interface[6]. In addition, wearable technology has a high market share because of its high availability, accessibility, and affordability[7]. The advantage is that users do not require many precautions and can use the product in their daily life[6]. The combination of wearable devices and smartphone apps provides a new platform that can help improve an individual's health behaviors[6]. A systematic review reported that people using wearable devices had increased PA and daily steps, regardless of their physical characteristics and health condition[8]. Previous studies on PA intervention using wearable devices showed that when postmenopausal women performed 16 weeks of moderate-to-vigorous physical activity (MVPA) and 10,000 steps of walking, their MVPA per week increased by 62 min and the daily average number of steps increased by 789 steps[9]. Wearable devices not only increase PA but also have a positive effect on weight loss and chronic disease management[10-12]. Therefore, this study aimed to evaluate the effects of a 12-week non-contact exercise intervention on body composition and health-related physical fitness in adults.

METHODS AND MATERIALS

Participants

One hundred adults (aged:33.97 ± 11.20 years) were initially enrolled; however, ninety-seven participants (men: n = 41, women: n = 56) completed the study. Three participants dropped out of the study because of personal reasons. All study procedures were approved by the Institutional Review Board of Konkuk University and conducted in accordance with the principles of the Declaration of Helsinki. Written informed consent was obtained from all the participants. Participants' characteristics are presented in Table 1.

Non-contact exercise intervention

Non-contact exercise was performed for 12 weeks using a smart tracker (Charge 4, Fitbit, USA) and mobile phone applications. Individual exercise intervention management was performed using an AI-Fit web page (Korea Institute of Industrial Technology, KITECH), which can be used by linking the Fitbit APP. The AI-Fit web page sets participants' exercise intensity through body composition, health-related physical fitness measurement data, and questionnaire, and based on this, presents a customized exercise program. In addition, the non-contact exercise intervention was conducted more efficiently through the manager checking the user data through the AI-Fit web page. Feedback was provided in real-time through a messenger service (Kakao Talk) linked to the AI-Fit web page. The non-contact exercise program included resistance, aerobic, and flexibility exercises.

Resistance exercise was performed two days per week and for 60 min per day. The resistance exercise consisted of 10 min of dynamic stretching, 40 min of the main exercise, and 10 min of static stretching. Resistance exercises comprised push-ups, side banding, arm curls, lunges, squats, donkey kicks, leg raises, burpee test, bridging, and planking. The training intensity was set at three sets of 10-15 repetitions (beginner:10 reps, intermediate:12 reps, advanced:15 reps) at a perceived exertion value of 7 or 8 on the OMNI-Resistance Exercise Scale of perceived exertion (0: extremely easy to 10: extremely hard).

Aerobic exercise was performed five days per week for 50 min per day. The aerobic exercise consisted of 10 min of dynamic stretching, 30 min of the main exercise, and 10 min of static stretching. Resistance exercises included walking, jogging, running, and cycling. The training intensity was set at a maximum heart rate (HR_{max}) of 60-85% (beginner: 60%, intermediate: 60-70%, advanced: 70-85%).

Flexibility exercise was performed five days per week for 10 minutes per day. The flexibility exercise comprised stretching the inside of the legs, stretching the front of the legs, stretching behind the legs, stretching the hips, stretching the sides, stretching the stomach, stretching the lower arm, stretching in front of the chest/shoulder, stretching the

Table 1. Physical characteristics of participants.

Variables	Total (n = 97)	Men (n = 41)	Women (n = 56)
Age (yrs)	33.97 ± 11.20	30.17 ± 9.51	37.75 ± 11.60
Height (cm)	166.88 ± 8.61	174.26 ± 4.59	161.49 ± 6.61
Weight (kg)	67.80 ± 12.36	75.52 ± 10.60	62.15 ± 10.39
BMI (Kg/m^2)	24.28 ± 3.72	24.83 ± 3.03	23.88 ± 4.14

Values are expressed as mean ± SD. BMI: body mass index.

Table 2. Non-contact exercise intervention program.

Frequency		Intensity		Exercise time (min)	Exercise types
Resistance exercise	2 days / week	OMNI scale 7-8	Beginner: 10 reps Intermediate: 12 reps Advanced: 15 reps	Stretching: 10 min	dynamic stretching
				Main exercise (3 sets): 40 min	push-ups, side-banding, arm curls, lunges, squats, donkey kick, leg raises, burpee test, bridging, planking
				Stretching: 10 min	static stretching
Aerobic exercise	5 days / week	HRmax 60~85%	Beginner: 60% Intermediate: 60-70% Advanced: 70-85%	Stretching: 10 min	dynamic stretching
				Main exercise: 30 min	walking, jogging, running, bicycle
				Stretching: 10 min	static stretching
Flexibility exercise	5 days / week	Minimum of 30 seconds for each movement		Main exercise: 10 min	stretching inside the legs, stretching front of the legs, stretching behind the legs, hip stretching, stretching the sides, stretching the stomach, back stretch, stretching the lower arm, stretching in front of the chest/shoulder, stretching on the back and shoulders, stretching the neck

HRmax: maximum heart rate.

back and shoulders, and stretching the neck. The training intensity was set to a minimum of 30 seconds for each movement. The details of the non-contact exercise program are presented in Table 2.

Measurements

Body composition

Body composition was measured using bioelectrical impedance analysis (BIA) with InBody 770 (Inbody, Seoul, Korea). Before measuring body composition, fasting was performed for 8 h and metallic materials were removed. Body composition, including weight, body mass index (BMI), fat mass, percent body fat, fat-free mass, and skeletal muscle mass was analyzed.

Health-related physical fitness

Health-related physical fitness tests included isometric muscle strength (handgrip strength; T.K.K. 5001, TAKEI, Tokyo, Japan), muscular endurance (sit-ups), flexibility (sit-and-reach; T.K.K. 5403, Flexion-D, Tokyo, Japan), and cardiorespiratory fitness (maximal oxygen uptake: VO_{2max}; Aero bike 75XLIII, Konami, Tokyo, Japan).

Statistical analysis

The power test was performed using G*Power 3.1.9.2 (Franz Faul, University of Kiel, Kiel, Germany) at an effect size of 0.35, a significance level of 0.05 (α=0.05), and a power of 0.8 for all statistical tests. G*Power showed that 81 participants had sufficient power for this study. Statistical analyses were performed using the SPSS software version 26 (IBM Corp., Armonk, NY, USA). The mean and standard deviation were calculated. The normality of the distribution of all dependent variables was verified using the Shapiro-Wilk test. One-way repeated measures ANOVA was used to determine changes among the three periods (pre-test, middle-test, and post-test) by dependent variables. The effect size was computed as partial eta squared values (η_p^2; small: ≥.01, medium: ≥.06, large: ≥.14). The statistical significance level was set at 0.05.

RESULTS

Body composition

Table 3 shows the changes in body composition during the three periods (pre-test, middle-test, and post-test). There were no significant changes in weight (F=.306, p=.737, η_p^2 =.003), BMI (F=1.211, p=.285, η_p^2 =.012), and fat mass (F=3.243, p=.051, η_p^2 =.033) among the three periods. However, significant changes were shown in percent body fat (F=4.993, p=.016, η_p^2=.049), fat-free mass (F=4.690, p=.024, η_p^2=.047), and skeletal muscle mass (F=5.623, p=.004, η_p^2=.055) among the three periods.

Health-related physical fitness

Table 4 indicates that there were significant changes in hand grip strength (F=12.167, p<.001, η_p^2=.112), sit-and-reach (F=20.497, p<.001, η_p^2=.176), sit-ups (F=42.107, p<.001, η_p^2=.305), and VO_{2max} (F=4.311, p=.037, η_p^2=.043) among the three periods.

DISCUSSION

The present study examined the effects of non-contact exercise intervention for 12 weeks on body composition and health-related physical fitness in adults. The findings of this study revealed that the non-contact exercise intervention reduced percent body fat and increased fat-free mass, skeletal muscle mass, hand grip strength, sit-and-reach, sit-ups, and VO_{2max}.

In recent years, studies on the effects of mobile health on body composition have drawn attention[13]. A tailored lifestyle self-management intervention (TALENT) study reported that intensive web-based lifestyle interventions showed effective results, with an average weight loss of approximate-

Table 3. Changes in body composition among the pre-test, middle-test, and post-test.

Variables	Pre-test	Middle-test	Post-test	*F*-value	prob>*F*	ES(η_p^2)
Weight (kg)	67.80 ± 12.36	67.90 ± 12.49	67.89 ± 12.48	.306	.737	.003
BMI (kg/m^2)	24.28 ± 3.72	24.43 ± 3.82	24.29 ± 3.67	1.211	.285	.012
Fat mass (kg)	18.63 ± 7.64	18.49 ± 7.54	18.35 ± 7.55	3.243	.051	.033
Percent body fat (%)	27.46 ± 9.24	27.13 ± 8.92	26.93 ± 8.97	4.993	.016 *	.049
Fat-free mass (kg)	49.17 ± 10.56	49.41 ± 10.71	49.91 ± 10.81	4.690	.024 *	.047
Skeletal muscle mass (kg)	27.31 ± 6.46	27.46 ± 6.57	27.53 ± 6.56	5.623	.004 **	.055

Values are expressed as mean ± SD. ES: effect size, BMI: body mass index. Significant difference among the groups: *P<.05, **P<.01.

Table 4. Changes in health-related physical fitness among the pre-test, middle-test, and post-test.

Variables	Pre-test	Middle-test	Post-test	*F*-value	prob>*F*	ES(η_p^2)
Hand grip strength (kg)	31.03 ± 9.71	31.86 ± 9.45	32.91 ± 9.91	12.167	.000 ***	.112
Sit-and-reach (cm)	9.24 ± 10.64	9.80 ± 10.13	11.21 ± 10.09	20.497	.000 ***	.176
Sit-ups (n)	24.01 ± 11.47	25.81 ± 11.53	28.34 ± 12.43	42.107	.000 ***	.305
VO_2max (mL/kg/min)	30.96 ± 7.90	32.16 ± 8.11	32.31 ± 7.86	4.311	.037 *	.043

Values are expressed as mean ± SD. ES: effect size, VO_2max: maximal oxygen uptake. Significant difference among the groups: *P<.05, ***P<.001.

ly 10% and a decrease in BMI, fat mass, and percent body fat[14]. Although previous studies did not use wearable devices for interventions[14], the results are consistent with our findings. Meta-analysis studies have verified that wearable technology intervention periods of 12 weeks or more are more effective for reducing BMI results than interventions of less than 12 weeks[6]. In addition, a weight-loss program using an activity tracker worn during exercise can provide an effective short-term intervention (less than six months) for middle-aged adults[15]. Similar to our study, interventions using the Fitbit wrist activity tracker showed positive changes in fat-free mass among overweight male and in percent body fat among overweight female[16]. A previous study using mobile applications with push notifications for PA and diet management reported a decrease in weight and fat mass in obese women[17]. Therefore, exercise interventions using wearable devices can improve body composition.

Since health-related physical fitness is associated with the prevalence and mortality of diseases, it is essential to manage health-related physical fitness by increasing PA[18,19]. Owens et al.[20] reported that 21 individuals in 8 households performed a PA intervention using Wii Fit for three months, resulting in no significant change muscle strength, muscle endurance, flexibility, and aerobic capacity. This result was due to the absence of increase in moderate-intensity PA over the three-month period, resulting in a lack of physiological stimulation and low exercise intensity using the Wii Fit[20]. Avila et al.[21] reported that 150 min of home training per week, with an intensity of HRR of 70-80%, for 12 weeks in 90 patients with coronary artery disease showed a tendency to increase VO_2peak, grip strength, and flexibility. Home training for patients with coronary artery disease effectively maintains health-related physical fitness over the long term[21]. Tallner et al.[22] reported that web-based PA using the MS-intact program positively affects muscle strength and lung function in patients with multiple sclerosis. However, web-based PA intervention studies should be conducted for at least ten weeks to be effective[23]. In line with these findings, the present study, which used exercise prescription and monitoring with smart tracker and mobile phone applications, obtained positive results for terms of health-related physical fitness.

CONCLUSION

The present study revealed that 12 weeks of non-contact exercise intervention improves body composition and health-related physical fitness among adults. Wearable technologies encourage individuals to improve their lifestyles by increasing PA and achieve the goal of maintaining health in this population.

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