Submitted: 15 September, 2022 Accepted: 21 December, 2022 Published: 30 December, 2022 DOI:10.22514/jomh.2022.009

JOMH
Journal of Men's Health

ORIGINAL RESEARCH

Once-weekly online video bodyweight resistance training during COVID-19: dose it affect body fat mass, muscle strength and quality of life in middle-aged men?

Junga Lee[1,*], Kwang-Hee Yoo[1]

[1]Graduate School of Sport Science, Kyung Hee University, 446-701 Yongin-si, Republic of Korea

***Correspondence**
junga613@gmail.com
(Junga Lee)

Abstract

The aim of the study was to investigate the effects of a once weekly, online video bodyweight resistance exercise training on body mass, muscle strength, and quality of life in middle-aged men (age 40–50 years) during a 20-week coronavirus (COVID-19) pandemic period. The participants were 30 healthy men, and the intervention lasted from June 2021 to September 2021. The participants were randomly assigned in two groups: an exercise group (n = 15) and a congrol group (n = 15). The exercise group participated in a 45-minute program including warm-up, resistance exercise, and recovery once per week for 20 weeks. The participants in the exercise group showed significantly reduced body mass (76.08 $\pm$ 8.80 kg), body mass index (BMI, 25.23 $\pm$ 2.39 kg$\cdot$m^{-2}), body fat mass (14.93 $\pm$ 4.97 kg), body fat percentage (19.42 $\pm$ 5.31%), and waist circumference (91.40 $\pm$ 6.13 cm) and increased handgrip strength (right: 48.49 $\pm$ 6.98 kg and left: 44.44 $\pm$ 6.39 kg) and quality of life (total score: 25.80 $\pm$ 2.651). Meanwhile, the control group showed increased body mass (77.06 $\pm$ 9.04 kg) and body fat mass (19.10 $\pm$ 4.95 kg) and decreased quality of life (total score: 24.60 $\pm$ 3.180). The once-weekly online video bodyweight resistance exercise program could be beneficial for body mass, muscular strength, and quality of life among middle-aged men.

Keywords

Body mass index; Body fat mass; Waist circumference; Handgrip strength

1. Introduction

During the past three years, the physical activity of many individuals has been restricted to prevent the spread of COVID-19 [1]. Several studies have reported decreased physical activity levels during the pandemic [2]. Moreover, COVID-19 has limited the sorts of spaces in which individuals can safely participate in physical activities such as walking, running, and swimming. Even before the pandemic, only one in three individuals routinely engaged in enough physical activity to meet the World Health Organization recommendation [3]. Participating in regular exercise including aerobic and resistance exercise two or three times a week for a total of 150 minutes is known to maintain health and prevent chronic diseases [4].

There is a critical time period for middle-aged men to derive the most benefit from participating on exercise [5–7]. Several studies have reported that middle-aged men have increased body mass and body fat mass and decreased muscle mass, muscle size, and muscle strength compared with their own body composition when they were in their middle 20s [8, 9]. A previous study reported that a cohort of individuals over 40 years old had lower muscle mass compared to a cohort of under-40 years which reflects muscle mass loss increases after age 40 [10]. It is crucial to maintain muscle mass over age 40 to prevent sarcopenia. Also, increased body fat and decreased muscle mass and muscle strength are predictors of chronic cardiometabolic diseases including obesity, diabetes, and metabolic syndrome [11]. The American College of Sports Medicine has recommended that men participate in strength exercise two or three times per week to improve their body composition and muscle strength, delay the inevitable muscle losses that occur with age, and prevent chronic disease [12]. Previous studies reported that participating in resistance exercise more than two times per week improved muscle mass, muscle strength, muscle endothelial function, and quality of life in middle-aged men [13–15]. In spite of those beneficial effects of participataing in exercise or sports, a previous study reported that a barrier to exercise participation in middle-aged men was not having enough time [16]. Moreover, several studies have reported that low physical activity is better than inactivity [17]. Knowing that exercise once a week benefits middle-aged men would motivate them into participating in exercise and would provide a new insight for exercise guidelines.

Delivering exercise training through an online platform could be an alternative for the middle-aged men who do not have enough time during the COVID-19 pandemic. Additionally, if a once-weekly exercise routine can produce beneficial effects, it could motivate middle-aged men to start exercising. This study was limited to middle-aged men who were unable to exercise two or three times per week and encouraged them to participate in once weekly strength exercise. Also, because COVID-19 pandemic public health guidelines recommend personal distancing, restricting the number of people gathered together, and wearing masks according to local government policies, randomized, controlled studies about the effectiveness of online video exercise interventions are needed. Therefore, the purpose of this study was to investigate the effects of a once-weekly online video bodyweight resistance exercise program on body fat mass, muscle strength, and quality of life in middle-aged men (aged 40–50 years). This study was conducted for 20 weeks to investigate the middle and long-term training effects of once a week exercise in middle-aged men. The hypothesis of this study was that once-weekly online video bodyweight resistance exercise training would decrease fat mass and improve muscle strength and quality of life in middle-aged men.

2. Materials and methods

2.1 Participants

Thirty men aged 40 to 50 years participated in this randomized controlled trial. The inclusion criteria were healthy men aged 40 to 50 years without any chronic diseases, including orthopedic diseases, hypertension, and diabetes and who had not participated in any exercise or restriction of caloric uptake or a specific nutritional diet in the preceding six months. The exclusion criteria were taking any medications and unwillingness to participate in bodyweight resistance exercise. An interview based on those inclusion and exclusion criteria was conducted to determine eligible participants for this study. The participants were recruited by advertisements on social networking services (SNS) and recruitment posts in online communities. The participants would be removed from the study if they did not attend more than 80% of training days, but they satisfied the attendance requirement. This study protocol was approved by the Institutional Review Board at Kyung Hee University. All participants provided written informed consent. All data were collected in an exercise physiology laboratory at Kyung Hee University between March 2021 and September 2021. This study was conducted during COVID-19 so the government controlled people's movements and gatherings were limited to less than 4 persons, public and private gyms were locked down, and all stores and restaurants closed at 9 pm.

The 30 enrolled participants were randomly divided into two groups: 15 to the exercise group and 15 to the control group (Fig. 1). SPSS version 26.0 (SPSS 26.0, Inc., Chicago, IL, USA, 2022) was used for randomized allocation of participants. All participants arrived at the laboratory at 7 a.m. after a 12-hour overnight fast. All measurements were made by the same researcher who was a trained exercise specialist.

2.2 Anthropometry

All participants wore light clothes. Body composition components, including height, body mass, fat mass, % fat mass and fat free mass, were measured using a bio-impedance analyzer (Inbody 720, Biospace, Seoul, Republic of Korea) [18]. Body height and body mass were measured, and body mass index was calculated as body mass (kg)/height (m^2). Waist circumference was measured along the horizontal line intersecting the midpoint between top of the iliac creast and lower margin fo the last rib using a tape measure [19].

2.3 Strength

Handgrip strength was measured using a hand dynamometer with adjustable handgrips (TKK 5101 Grip. D; Takei, Tokyo, Japan). Handgrip strength was measured twice on the left hand and three times on the right hand with a one-minute break between tests. The highest score from each hand was recorded in kilograms [20]. Self-reported dominant and non-dominant upper limbs were recorded. All participants reported their right side to be dominant.

2.4 Quality of life

Quality of life was measured using the Health-Related Quality of Life Instrument with 8 Items (HINT-8). The eight items were climbing stairs, pain, vitality, working, depression, memory, sleep, and happiness, and the total score was used as the HINT-8 index. Participants answered each question on the HINT-8 by choosing no problems, mild problems, moderate problems, or severe problems. The HINT-8 was translated from English version to Korean version and validated by previous study [21].

2.5 Online video bodyweight resistance exercise intervention

The exercise group at the first visit to the laboratory had one-hour exercise education session. Afterwards, the participants underwent once-weekly online video bodyweight resistance training. All participants in the exercise group reported their own exercise training attendance by email or SNS. The resistance exercise program was designed by an exercise specialist who also managed the training. The 45 minutes bodyweight resistance exercise intervention consisted of a 5-minute warm-up, 35 minutes of bodyweight resistance exercise, and a 5-minute cool-down (Table 1). The warm-up including marching, light jogging, stretching, and rotation of all body joints to increase the heart rate and body temperature. The bodyweight resistance exercises were push-ups, squats, bridges, sit-ups, leg raises, and back extensions without any added dumbbells or barbells. Each resistance exercise was 12-repitition and 3-set. A one-minute break between the sessions of each exercise was assigned. The heart rate of each participant was monitored using a polar heart rate monitor to maintain exercise intensity of 60% HR reserve. The cool-down period involved stretching, rotation of joints, and deep breathing to promote recovery. After completing the 45 minutes exercise, all participants wrote their rate of perceived exertion using the Borg-15 Scale [22] and questions. This study used an online video exercise intervention on online platform. The exercise trainers who designed the exercise programs and educated the participants in this study interacted with participants using online platform

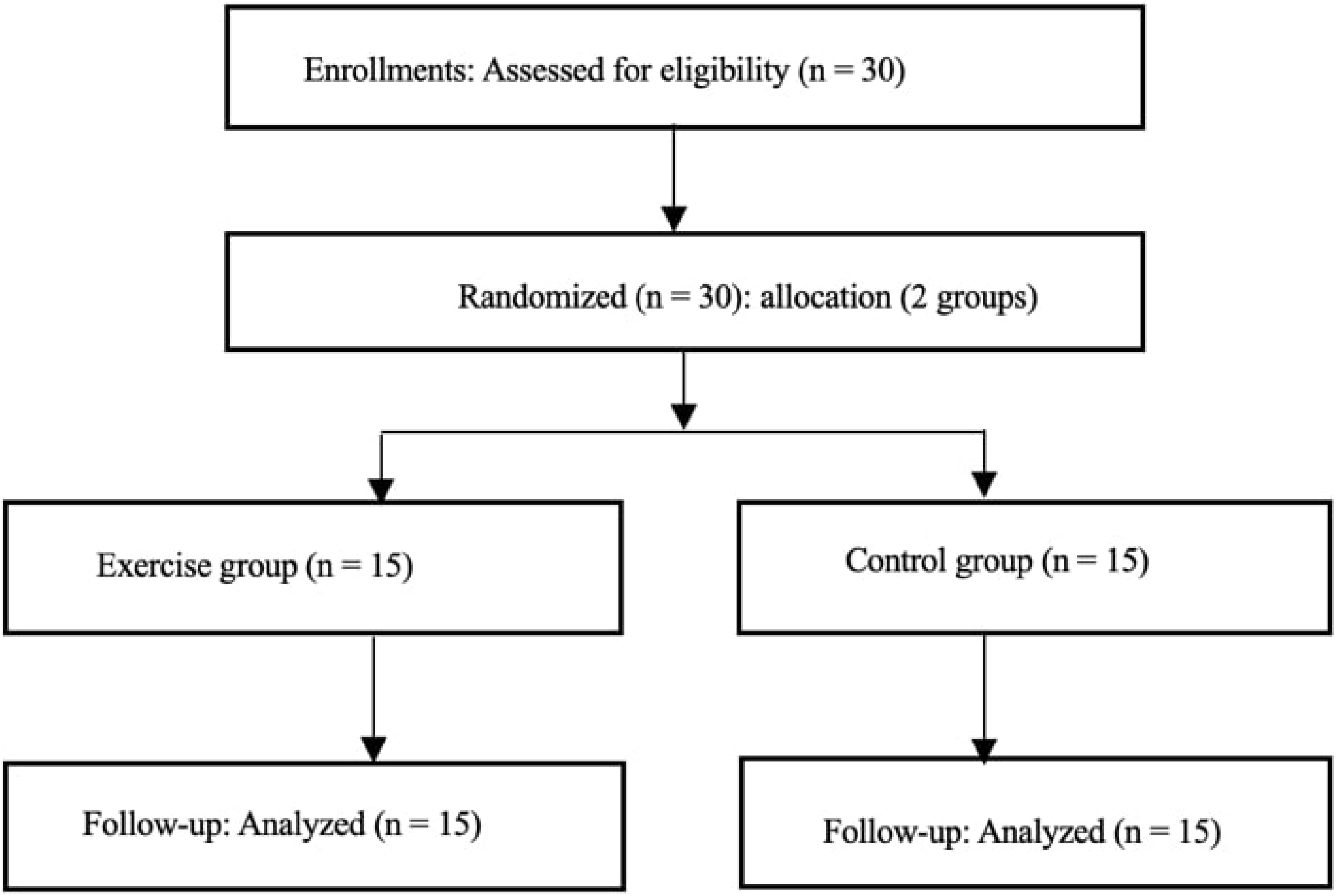

FIGURE 1. Flow chart of the study.

TABLE 1. A bodyweight resistance exercise training.

Warm-up	Stretching	5-minute
Exercise Bodyweight Resistance		
	Push-up	A one-minute break between the sessions of each exercise 12-repitition & 3-set 35-minute
	Squat	
	Bridge	
	Sit-up	
	Leg raise	
	Back extension	
Recovery	Stretching	5-minute

TABLE 2. Physical characteristics of participants.

Variables	Experimental (Mean ± SD)	Control (Mean ± SD)	*p*
Age (yrs)	44.27 ± 4.51	49.13 ± 5.96	0.018
Height (cm)	173.67 ± 5.47	172.00 ± 5.42	0.409
Body mass (kg)	77.59 ± 10.11	76.50 ± 9.37	0.534
BMI ($kg \cdot m^{-2}$)	25.71 ± 2.77	25.43 ± 2.09	0.751
Fat mass (kg)	17.33 ± 5.70	17.07 ± 4.75	0.776
%BF (%)	22.09 ± 5.78	22.12 ± 4.54	0.969

BMI: Body mass index, %BF: Percent body fat, SD: Standard deviation.

comments and SNS, including kakaotalk, where the participants reported their attendance, questions, and recovery heart rates.

2.6 Statistical analysis

Thirteen participants per group were needed to detect a large, standardized effect size ($d = 0.8$) with a statistical power of 0.80 and a two-tailed α of .05. To accommodate a 10% loss-to-follow-up, 30 participants were recruited.

Statistical analysis was performed using SPSS version 26.0 software (SPSS Inc, Chicago, IL). We conducted a normality test. The Kolmogorov-Smirnov test result ($p > 0.05$) was normal distribution. Independent t-test of continuous data was used to present the baseline descriptive statistics. Repeated measures analysis of variance was used to detect interactions between Time (2) and Group (2) on body composition, muscle strength, and quality of life and to provide values of partial η^2. Post-hoc analyses were used to find significant interactions, paired t-tests to find differences before and after exercise intervention, and independent-sample t-tests to find differences between the two groups. Non-parametric data, including quality of life from the HINT-8 questionnaire, were analyzed using the Wilcoxon signed rank test for within-group changes and the Mann-Whitney test for inter-group changes. The HINT-8 analyses included both dimensional and total scores. The effect size on body composition and handgrip strength was calculated by partial eta squared. If the effect size was <0.01, we categorized it as a small effect size, $0.01<$ and >0.06 as a medium effect size, and >0.14 as a large effect size [23]. The effect size for quality of life was calculated by a Wilcoxon signed rank test by dividing the test statistic by the square root of the number of observations. The effect size for quality of life was categorized as a small effect size (>0.1), medium effect size ($0.1<$ and >0.3), or large effect size (>0.5) [23].

3. Results

None of the participants dropped out of this study. The rate of attendance for the bodyweight resistance exercise intervention was 89%. The baseline characteristics are provided in Table 2.

3.1 Body composition

The results of body composition is presented in Table 3. The men who participated in the bodyweight resistance exercise had significantly decreased body mass, BMI, body fat mass, percentage body fat, and waist circumference after the intervention, but neck circumference and lean body mass did not change significantly. Meanwhile, the men in the control group had significantly increased body fat mass, percentage body fat, and waist circumference at the end of the study, but their body mass, BMI, lean body mass, and neck circumference did not change significantly.

3.2 Muscle strength

The results of muscle strength are provided in Table 3. After completing the bodyweight resistance exercise intervention, the handgrip strength in the right hand increased significantly in the men in the exercise group, but left-hand strength did not change significantly. In the men in the control group, handgrip strength in both hands decreased significantly.

3.3 Quality of life

Significant within-group differences were found in quality of life (Table 4). Men who participated in the resistance exercise reported increases in vitality (physical dimension) and total HINT-8 score, whereas the men in the control group reported significantly decreased stair climbing ability, vitality (mental dimension), positivity, and total HINT-8 score. Also, the men in the control group reported significantly increased pain and depression.

No inter-group differences between the exercise and control groups were found in any items of the HINT-8 at baseline. After the bodyweight resistance exercise intervention, men in the exercise group reported significantly decreased depression.

3.4 Effect size

Body composition and handgrip strength had large effect sizes. Only pain in the quality of life assessment had a medium effect size. All other factors, including physical dimension, climbing stairs, vitality, social dimension, mental dimension, depression, memory, sleep, positive dimension, and total score, had small effect sizes.

4. Discussion

Middle age (40–50 years) is a crucial time for men due to declines in physical and physiological function, including muscle mass and muscle strength, which increase the risks of chronic diseases such as obesity, metabolic syndrome, and cardiovascular disease. Those physical and physiological changes can also influence on their body composition, strength, and quality of life (including mental health components such as vitality, depression, and happiness) of middle-aged men. To delay the physical and physiological declines caused by aging, performance of resistance exercise two to three times per week has been recommended [12]. However, many middle-aged men do not participate in resistance exercise at all. Knowing that even one session of bodyweight resistance exercise a week is beneficial might help to motivate otherwise sedentary middle-aged men to begin an exercise program. Due to the COVID-19 pandemic, a non-face-to-face exercise intervention, such as an online video, might be more useful than a traditional exercise intervention. Therefore, this study tested whether participating in a once-weekly online video bodyweight resistnace exercise intervention for 20 weeks would improve body composition, muscle strength, and quality of life of middle-aged men.

Body composition and handgrip strength improved in the middle-aged men who participated in the exercise intervention. A previous study reported that muscle strength in adult men was inversely related to body fat [24]. The decreased body fat found in the resistance exercise group in this study is consistent with the results of previous studies in middle-aged men [25]. High-intensity, twice weekly resistance machine exercise for 12 weeks reduced body fat and increased back-extensor strength [26]. However, this study did not find a significant

TABLE 3. Body composition and muscle strength.

Variables	Groups	Time (Mean ± SD) Pre	Post	Δ%	F-values	p (η^2)
Body mass (kg)						
	Experimental	77.59 ± 10.10	76.08 ± 8.80*	−1.95	Group 0.033	0.858 (0.001)
					Time 0.018	0.896 (0.001)
	Control	75.41 ± 8.79	77.06 ± 9.04	2.19	Group × Time 8.148	0.008 (0.225)++
Body mass index ($kg{\cdot}m^{-2}$)						
	Experimental	25.71 ± 2.76	25.23 ± 2.39*	−1.87	Group 0.080	0.779 (0.003)
					Time 0.049	0.827 (0.002)
	Control	25.42 ± 2.09	25.99 ± 2.17	2.24	Group × Time 8.433	0.007 (0.231)++
Fat mass (kg)						
	Experimental	17.33 ± 5.69	14.93 ± 4.97*	−13.85	Group 1.175	0.288 (0.040)
					Time 0.012	0.912 (0.000)
	Control	16.82 ± 3.74	19.10 ± 4.75*	13.56	Group × Time 21.208	0.000 (0.431)+++
Percent body fat (%)						
	Experimental	22.08 ± 5.78	19.42 ± 5.31*	−12.05	Group 2.546	0.122 (0.083)
					Time 0.076	0.784 (0.003)
	Control	22.15 ± 3.05	24.51 ± 4.01*	10.65	Group × Time 21.354	0.000 (0.433)+++
Fat free mass (kg)						
	Experimental	34.22 ± 4.53	34.83 ± 4.26	1.78	Group 1.240	0.275 (0.042)
					Time 0.445	0.510 (0.016)
	Control	33.10 ± 3.69	32.76 ± 3.23	−1.03	Group × Time 5.417	0.027 (0.162)+
Waist circumference (cm)						
	Experimental	93.43 ± 7.02	91.40 ± 6.13*	−2.17	Group 0.034	0.855 (0.001)
					Time 0.702	0.409 (0.024)
	Control	91.40 ± 5.83	94.23 ± 5.15*	3.1	Group × Time 25.963	0.000 (0.481)+++
The right grip strength (kg)						
	Experimental	45.80 ± 8.40	48.49 ± 6.98*	5.87	Group 0.022	0.114 (0.087)
					Time 0.498	0.059 (0.121)
	Control	44.79 ± 7.92	40.41 ± 7.52*	−9.78	Group × Time 19.241	0.000 (0.706)+++
The left grip strength (kg)						
	Experimental	43.22 ± 6.51	44.44 ± 6.39	2.82	Group 0.306	0.391 (0.026)
					Time 0.710	0.069 (0.113)
	Control	44.51 ± 6.38	40.40 ± 5.64	−9.23	Group × Time 14.004	0.000 (0.638)+++

** $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$: Significant difference between pre and post-test.*
+ $p < 0.05$, ++ $p < 0.01$, +++ $p < 0.001$: Significant main effect and/or interaction.
SD: Standard deviation.

TABLE 4. Results of quality of life.

Scales	Groups	Tests (mean ± SD) Pre	Post	U	p (η^2)
Physical dimension					
	Experimental	8.80 ± 1.146	9.53 ± 0.743**	87.500	0.305 (−0.043)
	Control	9.86 ± 2.030	9.06 ± 1.579*		
Climbing stairs					
	Experimental	3.27 ± 0.704	3.47 ± 0.516	93.500	0.436 (−0.069)
	Control	3.53 ± 0.640	3.27 ± 0.594*		
Pain					
	Experimental	3.00 ± 0.000	3.00 ± 0.000	105.000	0.775 (−0.365)
	Control	3.33 ± 0.724	3.07 ± 0.594*		
Vitality					
	Experimental	2.53 ± 0.834	3.07 ± 0.594**	81.500	0.202 (−0.211)
	Control	3.00 ± 0.845	2.73 ± 0.594*		
Social dimension (Working)					
	Experimental	3.47 ± 0.516	3.47 ± 0.516	108.500	0.870 (−0.082)
	Control	3.40 ± 0.632	3.40 ± 0.632		
Mental dimension					
	Experimental	9.60 ± 1.298	9.93 ± 1.099	96.000	0.512 (−0.221)
	Control	10.26 ± 1.279	9.60 ± 1.055***		
Depression					
	Experimental	3.27 ± 0.704	3.47 ± 0.516	56.000	0.019# (−0.275)
	Control	3.47 ± 0.516	2.93 ± 0.258**		
Memory					
	Experimental	3.20 ± 0.561	3.20 ± 0.561	100.000	0.624 (0.000)
	Control	3.33 ± 0.488	3.33 ± 0.488		
Sleep					
	Experimental	3.13 ± 0.640	3.27 ± 0.458	103.000	0.713 (0.000)
	Control	3.47 ± 0.640	3.33 ± 0.617		
Positive dimension (Happiness)					
	Experimental	2.73 ± 0.799	2.87 ± 0.743	85.500	0.267 (−0.150)
	Control	2.80 ± 0.775	2.53 ± 0.516*		
Total score					
	Experimental	24.60 ± 3.333	25.80 ± 2.651***	90.000	0.367 (−0.144)
	Control	26.33 ± 4.203	24.60 ± 3.180***		

*$p < 0.05$, **$p = 0.005$, ***$p < 0.005$: Significant difference between pre and post-test.
#$p < 0.05$, Significant difference between experimental group and control group.
SD: Standard deviation.

increase in lean body mass, presumably because the frequency and intensity of exercise in this intervention were not enough to increase the lean body mass of middle-aged men. Increasing the frequency and intensity of resistance exercise training and adding protein to the diet might increase the lean body mass of middle-aged men. A previous meta-analysis reported that dietary protein supplementation two to five times per week alongside resistance exercise training induced increases in one-repetition-maximum strength, free fat mass, and muscle size including muscle fiber cross-sectional area in healthy adults [27]. Participating in resistance exercise and taking dietary protein supplements could help middle-aged men enhance their muscle strength and mass [28]. A previous study reported that middle-aged men who performed resistance exercise had smaller increases in waist circumference 12 years later, which is consistent with the finding of the present study [29]. The increased waist circumference, body fat mass, and percentage body fat in the control group might be related to the COVID-19 pandemic, which has restricted individuals' physical and social activity and promoted increasingly sedentary lifestyles, including working from home, and stress. The participants in the current study had already lived in the pandemic environment for more than one year when the study began. The results of this study indicate that participating in bodyweight resistance exercise once per week is helpful for improving the body composition and muscle strength of middle-aged men.

Quality of life also increased in the middle-aged men who completed the 20-week, once weekly bodyweight resistance exercise. A previous study reported that resistance exercise improved quality of life [27]. Another previous study investigated spinal balance, thoracic spinal range of motion, back muscle strength, and gait speed and found that they correlated with better quality of life in middle-aged and elderly people [30]. All activity related to everyday life, including body balance, range of motion in all body joints, muscle strength, and gait speed, were enhanced after middle-aged men completed resistance exercise interventions [31]. Participating in regular exercise that improved fitness levels was also associated with increased health-related quality of life in middle-aged and elderly people [32].

The bodyweight resistance exercise intervention in this study consisted of push-ups, squats, bridges, sit-ups, leg raises, and back extensions without any added weight. Bodyweight resistance exercise, *i.e.*, strength exercise without additional load or equipment, could be beneficial for middle-aged men who are otherwise inactive because it minimizes the risk of injury from unfamiliar equipment. Another beneficial effect of resistance exercise without any additional load is a reduced risk of knee injury [33]. Middle-aged men with experience of knee injury or pain but no symptoms of orthopractic problems could assess their knee condition and gradually increase the frequency and intensity of exercise. Increasing of number of repetitions per set of exercises is a safe and effective way to increase the intensity of resistance exercise.

During the COVID-19 pandemic, an online video exercise intervention might be a good way to encourage middle-aged men to participate in exercise. This study found that a once weekly video exercise intervention for middle-aged men had beneficial effects. A previous study reported that using video exercise and mobile applications for 2.8 sessions per week for 8 weeks increased physical activity and decreased depression in inactive women [34]. Another previous study reported that an exercise intervention using a live online video via Skype for patients with cystic fibrosis was technologically feasible and acceptable to patients, but it did not investigate the outcomes of the exercise intervention [35]. This study used online platform and SNS to commnitate with the participants and reports the clinical outcomes of body composition, strength, and quality of life. The interactions between the participants and exercise trainers produced a tailored exercise intervention that helped to motivate participants and improve the beneficial effects of the exercise intervention.

Bodyweight resistance exercise is anaerobic, using glycogen as the main energy source and increasing both lean body mass and basal metabolic rate [36]. Those processes help to control body mass. Prolonged participation in resistnace exercise increases muscle strength and basal metabolic rate, which helps to decrease body mass and body fat mass. Additionally, resistance exercise delays age-related decreases in lean body mass and muscle strength and increases the production of growth hormone, which affects developing muscle fibers and their function [37–39]. Other benefits of exercise are decreased insulin and leptin resistance and increased insulin and leptin sensitivity, which also help to reduce body fat [12, 40, 41]. Participating in resistance exercise increases serotonin level and decreases cortisol level, which are related to quality of life because those hormone level changes decrease depression and pain and increase happiness and vitality [42].

This study has several limitations. First, although it was mainly an online video exercise intervention, the men in the exercise intervention group had a one-hour face-to-face exercise education session to ensure that their resistance exercise on the first day was correct. That might have influenced the outcomes of the resistance exercise intervention. Second, the diet of the participants was not controlled and might have influenced the results, although participants were told to maintain their usual diet throughout the study. Third, to generalize the beneficial effects, a larger sample size might be needed. Fourth, in assessing the rate of perceived exertioin (RPE) with the Borg-15 Scale, the participants recorded their own values after completing the one-hour exercise program, not during the exercise, but their heart rates were monitored in all the exercise sessions, and no one reported any health issues. Lastly, while handgrip strength is an indicator of strength and is associated with chronic diseases in clinical settings when low, other strength tests, such as the one repetition maximum,should be included in future studies.

5. Conclusions

Middle-aged men face physical declines, including decreasing muscle mass and muscle strength and increasing body fat, but participating in a once-weekly online video bodyweight resistance exercise intervention could delay those changes. Also, participating in resistance exercise could help to improve quality of life. During COVID-19, activity restrictions could lead middle-aged men to become more stressed and inactive than they were before, which could accelerate age-related physiological and psychological declines. This study explored the beneficial effects of a once-weekly online video body-weight resistance exercise intervention, and these findings could encourage middle-aged men to participate in resistance exercise.

AUTHOR CONTRIBUTIONS

These should be presented as follows: JL and KY—contributed to conception, development, and design of the study, method, analysis reports, and data collection. JL—led manuscript preparation. JL and KY—contributed to, read, and the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The study was approved by Kyung Hee University's Institutional Review Board (IRB#KHGIRB-21-225).

ACKNOWLEDGMENT

We gratefully acknowledge the engagement of the participants.

FUNDING

This research received no external funding.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

[1] World Health Organization. Physical activity. World Health Organization: Generva, Switzerland. 2020.

[2] Mutz M, Abdel Hadi S, Häusser JA. Work and sport: relationships between specific job stressors and sports participation. Ergonomics. 2020; 63: 1077–1087.

[3] World Health Organization. Coronavirus disease (COVID-19) pandemic. World Health Organization: Generva, Switzerland. 2019.

[4] Lavie CJ, Arena R, Swift DL, Johannsen NM, Sui X, Lee D, *et al*. Exercise and the cardiovascular system. Circulation Research. 2015; 117: 207–219.

[5] Izquierdo M, Häkkinen K, Ibáñez J, Kraemer WJ, Gorostiaga EM. Effects of combined resistance and cardiovascular training on strength, power, muscle cross-sectional area, and endurance markers in middle-aged men. European Journal of Applied Physiology. 2005; 94: 70–75.

[6] Timpka S, Petersson IF, Zhou C, Englund M. Muscle strength in adolescent men and risk of cardiovascular disease events and mortality in middle age: a prospective cohort study. BMC Medicine. 2014; 12: 62.

[7] Yamamoto S, Hotta K, Ota E, Mori R, Matsunaga A. Effects of resistance training on muscle strength, exercise capacity, and mobility in middle-aged and elderly patients with coronary artery disease: a meta-analysis. Journal of Cardiology. 2016; 68: 125–134.

[8] Janssen I, Heymsfield SB, Wang Z, Ross R. Skeletal muscle mass and distribution in 468 men and women aged 18–88 yr. Journal of Applied Physiology. 2000; 89: 81–88.

[9] Kennis E, Verschueren S, Van Roie E, Thomis M, Lefevre J, Delecluse C. Longitudinal impact of aging on muscle quality in middle-aged men. AGE. 2014; 36: 9689.

[10] Lynch NA, Metter EJ, Lindle RS, Fozard JL, Tobin JD, Roy TA, *et al*. Muscle quality. I. Age-associated differences between arm and leg muscle groups. Journal of Applied Physiology. 1999; 86: 188–194.

[11] Hurley BF, Hanson ED, Sheaff AK. Strength training as a countermeasure to aging muscle and chronic disease. Sports Medicine. 2011; 41: 289–306.

[12] American College of Sports Medicine, Riebe D, Ehrman JK, Liguori G, Magal M. ACSMs guidelines for exercise testing and prescription 10th ed. Lippincott Williams & Wilkins : Wolters KluwerPhiladelphia. 2019.

[13] Bagheri R, Rashidlamir A, Motevalli MS, Elliott BT, Mehrabani J, Wong A. Effects of upper-body, lower-body, or combined resistance training on the ratio of follistatin and myostatin in middle-aged men. European Journal of Applied Physiology. 2019; 119: 1921–1931.

[14] Boeno FP, Farinha JB, Ramis TR, Macedo RCO, Rodrigues-Krause J, do Nascimento Queiroz J, *et al*. Effects of a single session of high- and moderate-intensity resistance exercise on endothelial function of middle-aged sedentary men. Frontiers in physiology. 2019; 10: 777.

[15] Westcott WL. Resistance Training is Medicine: effects of strength training on health. Current Sports Medicine Reports. 2012; 11: 209–216.

[16] Justine M, Azizan A, Hassan V, Salleh Z, Manaf H. Barriers to participation in physical activity and exercise among middle-aged and elderly individuals. Singapore Medical Journal. 2013; 54: 581–586.

[17] Blair SN. Physical inactivity: the biggest public health problem of the 21st century. British Journal of Sports Medicine. 2009; 43: 1–2.

[18] Khalil SF, Mohktar MS, Ibrahim F. The theory and fundamentals of bioimpedance analysis in clinical status monitoring and diagnosis of diseases. Sensors. 2014; 14: 10895–10928.

[19] Taylor RW, Jones IE, Williams SM, Goulding A. Evaluation of waist circumference, waist-to-hip ratio, and the conicity index as screening tools for high trunk fat mass, as measured by dual-energy X-ray absorptiometry, in children aged 3–19 y. The American Journal of Clinical Nutrition. 2000; 72: 490–495.

[20] Crosby CA, Wehbé MA, Mawr B. Hand strength: normative values. The Journal of Hand Surgery. 1994; 19: 665–670.

[21] Kim J, Lee H, Jo M. Health-related quality of life instrument with 8 items for use in patients with type 2 diabetes mellitus: a validation study in Korea. Journal of Preventive Medicine and Public Health. 2022; 55: 234–242.

[22] Lagally KM, Robertson RJ. Construct validity of the OMNI resistance exercise scale. The Journal of Strength and Conditioning Research. 2006; 20: 252–256.

[23] Cohen J. Statistical Power Analysis for the Behavioral Sciences. 2nd ed. Erlbaum: NJ. 1998.

[24] Jackson AW, Lee D, Sui X, Morrow JR, Church TS, Maslow AL, *et al*. Muscular strength is inversely related to prevalence and incidence of obesity in adult men. Obesity. 2010; 18: 1988–1995.

[25] Kerksick CM, Wilborn CD, Campbell BI, Roberts MD, Rasmussen CJ, Greenwood M, *et al*. Early-phase adaptations to a split-body, linear periodization resistance training program in college-aged and middle-aged men. Journal of Strength and Conditioning Research. 2009; 23: 962–971.

[26] Kemmler W, Teschler M, Weißenfels A, Bebenek M, Fröhlich M, Kohl M, *et al*. Effects of whole-body electromyostimulation versus high-intensity resistance exercise on body composition and strength: a randomized controlled study. Evidence-Based Complementary and Alternative Medicine. 2016; 2016: 1–9.

[27] Morton RW, Murphy KT, McKellar SR, Schoenfeld BJ, Henselmans M, Helms E, *et al*. A systematic review, meta-analysis and meta-regression of the effect of protein supplementation on resistance training-induced gains in muscle mass and strength in healthy adults. British Journal of Sports Medicine. 2018; 52: 376–384.

[28] Kukuljan S, Nowson CA, Sanders K, Daly RM. Effects of resistance exercise and fortified milk on skeletal muscle mass, muscle size, and functional performance in middle-aged and older men: an 18-mo randomized controlled trial. Journal of Applied Physiology. 2009; 107: 1864–1873.

[29] Mekary RA, Grøntved A, Despres J, De Moura LP, Asgarzadeh M, Willett WC, *et al*. Weight training, aerobic physical activities, and long-term waist circumference change in men. Obesity. 2015; 23: 461–467.

[30] Imagama S, Hasegawa Y, Matsuyama Y, Sakai Y, Ito Z, Hamajima N, *et al*. Influence of sagittal balance and physical ability associated with exercise on quality of life in middle-aged and elderly people. Archives of Osteoporosis. 2011; 6: 13–20.

[31] Granacher U, Muehlbauer T, Doerflinger B, Strohmeier R, Gollhofer A. Promoting strength and balance in adolescents during physical education: effects of a short-term resistance training. Journal of Strength and Conditioning Research. 2011; 25: 940–949.

[32] Olivares PR, Gusi N, Prieto J, Hernandez-Mocholi MA. Fitness and health-related quality of life dimensions in community-dwelling middle aged and older adults. Health and Quality of Life Outcomes. 2011; 9: 117.

[33] Peeler J, Christian M, Cooper J, Leiter J, MacDonald P. Managing knee osteoarthritis: the effects of body weight supported physical activity on joint pain, function, and thigh muscle strength. Clinical Journal of Sport Medicine. 2015; 25: 518-523.

[34] Mascarenhas MN, Chan JM, Vittinghoff E, Van Blarigan EL, Hecht F. Increasing physical activity in mothers using video exercise groups and exercise mobile apps: randomized controlled trial. Journal of Medical Internet Research. 2018; 20: e179.

[35] Tomlinson OW, Shelley J, Trott J, Bowhay B, Chauhan R, Sheldon CD. The feasibility of online video calling to engage patients with cystic fibrosis in exercise training. Journal of Telemedicine and Telecare. 2020; 26: 356–364.

[36] Pratley R, Nicklas B, Rubin M, Miller J, Smith A, Smith M, *et al*. Strength training increases resting metabolic rate and norepinephrine levels in healthy 50- to 65-yr-old men. Journal of Applied Physiology. 1994; 76: 133–137.

[37] Mero AA, Hulmi JJ, Salmijärvi H, Katajavuori M, Haverinen M, Holviala J, *et al*. Resistance training induced increase in muscle fiber size in young and older men. European Journal of Applied Physiology. 2013; 113: 641–650.

[38] Yarasheski KE, Campbell JA, Smith K, Rennie MJ, Holloszy JO, Bier DM. Effect of growth hormone and resistance exercise on muscle growth in young men. The American Journal of Physiology. 1992; 262: E261–E267.

[39] Yarasheski KE, Zachwieja JJ, Campbell JA, Bier DM. Effect of growth hormone and resistance exercise on muscle growth and strength in older men. The American Journal of Physiology. 1995; 268: E268–E276.

[40] Klimcakova E, Polak J, Moro C, Hejnova J, Majercik M, Viguerie N, *et al*. Dynamic strength training improves insulin sensitivity without altering plasma levels and gene expression of adipokines in subcutaneous adipose tissue in obese men. The Journal of Clinical Endocrinology & Metabolism. 2006; 91: 5107–5112.

[41] Ropelle ER, Flores MB, Cintra DE, Rocha GZ, Pauli JR, Morari J, *et al*. IL-6 and IL-10 anti-inflammatory activity links exercise to hypothalamic insulin and leptin sensitivity through IKKbeta and ER stress inhibition. PLoS Biology. 2010; 8: e1000465.

[42] Nazari M, Shabani R, Dalili S. The effect of concurrent resistance-aerobic training on serum cortisol level, anxiety, and quality of life in pediatric type 1 diabetes. Journal of Pediatric Endocrinology & Metabolism. 2020; 33: 599–604.

How to cite this article: Junga Lee, Kwang-Hee Yoo. Once-weekly online video bodyweight resistance training during COVID-19: dose it affect body fat mass, muscle strength and quality of life in middle-aged men? Journal of Men's Health. 2022; 18(12): 68-76. doi: 10.22514/jomh.2022.009.