วารสารวิทยาศาสตร์และเทคโนโลยีการกีฬา ปีที่ 21 ฉบับที่ 2, ธันวาคม 2564

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Original article

HOME-BASED STRENGTH AND BALANCE INTERVENTION FOR PROMOTING PHYSICAL FUNCTION AND HEALTH RISK FACTORS IN OLDER ADULTS

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ABSTRACT

Introduction: Older people are at increased risk for health and falls. Maintaining physical function and health is therefore important. The aim of this study was to investigate the effectiveness of home-based strength and balance training in improving health risk factors and physical function in older people. **Methods:** Forty-eight participants (57±6.18) were assigned to the intervention group and the control group. MANOVA was used to analyze participants' physical function and health risk factors at baseline and posttest. **Results:** There were significant differences between the intervention and control groups in triglycerides, one leg stand, sit to stand, time up and go, and 11-meter walk (all, p.05). The intervention significantly decreased cholesterol levels, triglyceride levels, and percent body fat, and significantly increased blood glucose levels and the ability to stand on one leg, sit to stand, time up and go, and 11-meter walk. (all, $p < .05$). **Conclusions:** Overall, 16 weeks of home strength and balance training can improve physical function in older people and some health risk factors. The study suggests that older people should exercise regularly to improve their muscle strength and balance. In addition, older people are advised to meet with a specialist so they can safely perform the exercises themselves.

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Keywords: Triglyceride/ One-leg stand/ Timed up and go/ Sit to stand/ 11 meters walk

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INTRODUCTION

The number of older people has increased this decade and this trend is expected to continue in the coming decades, especially in Asian countries. [1]. Thailand has become an aging society since 2014. More than 10 million elderly people account for 10 percent of the total population. It is also predicted that the country will be an 'aged' society in 2031 and an ' super-aged' society in 2050, where 20% and 30% of the total population are elderly citizens. [2].. The problems that accompany the elderly are health risk factors such as high blood pressure, high blood lipids, disturbed blood sugar, overweight or obesity, and falls. The leading cause of injury in the elderly is falls [3, 4]. The most important component in preventing falls is recognizing significant risk variables. Although falls have been associated with more than 400 risk factors, the major factors have been determined to be decreased stability and postural control [5].

It is well known that older adults should engage in at least 150 minutes of moderate to vigorous exercise per week (PA) or 75 minutes of vigorous PA (e.g., 30 minutes per day, 5 days per week), which includes aerobic activity, muscle-strengthening activity, and balance training [6]. Daily PA is a positive element in the prevention and treatment of frailty, both functional and psychological, and in the prevention of non-communicable chronic diseases such as cardiovascular disease, some cancers, and type 2 diabetes [7]. In addition, a previous study found that older adults with chronic diseases have an increased risk of falls [8]. Although regular physical activity has been shown to improve stability, reduce fall risk, and improve overall health and well-being, especially in the aging population [9], it is particularly important that PA focus on strength and balance exercises to improve muscle strength and stability [10]. The effectiveness of fall prevention to improve physical function should be individualized and progressive, encompassing muscle strength, balance, and walking ability [11].

Continued participation in the supervised exercise program for the elderly has some barriers, such as travel, lack of variety, or facilities. An alternative that has been offered is that the elderly can have a PA in the home. In addition, home-based exercise programs can help older people maintain their independence, physical and mental health, and well-being [12]. Therefore, the aim of this study was to investigate the effectiveness of home-based strength and balance training in improving health risk factors (glucose, cholesterol, triglycerides, high-density lipoprotein (HDL) cholesterol, low-density lipoprotein (LDL), cholesterol, and body fat) and physical functions of older people (balance, walking ability, and lower extremity muscle strength). The authors hypothesized that participants in the intervention group would show significant improvements in health risk factors and physical function compared to participants in the control group.

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MATERIAL AND METHODS

Participants

A quasi-experimental pretest and posttest design was used. The number of participants was based on a power analysis conducted for the intervention factor (2 levels), the time factor (2 levels), and the interaction effect of intervention with time. Because the intervention and control groups were compared on health risk factors (e.g., triglycerides) and physical functioning (e.g., standing on one leg), a large effect size (Cohen's f=.5) was assumed for the interaction group. With a power of 0.80, an effect size of 0.5, and an alpha level of 0.05 for the main and interaction effects, 17 participants per group were required. A review of the literature on physical activity interventions revealed that the average dropout rate was approximately 30%. Therefore, a sample of at least 22 participants per group was recruited. Older adults in a local community in Thailand's Nakhon Nayok province were recruited by the director of PhromPhet Health Promoting Hospital. Participants were screened for eligibility through an interview and health screening. Criteria included: elderly aged 50-80 years, suffering from non-communicable diseases, and able to stand and walk independently. Exclusion criteria included participants who were limited in physical activity due to cardiac/pulmonary disease such as cardiovascular disease and pulmonary disease.

Sixty older adults expressed interest in participating in this study, but 12 were deemed ineligible because they were under fifty years of age. Thus, 48 older adults participated in this study. Twenty-four participants who had non-communicable diseases were in the home-based intervention group and another twenty-four participants were in the control group. Eligible participants completed the informed consent form, which had been reviewed and approved by the appropriate university ethics committees (SWUEC 369/2561).

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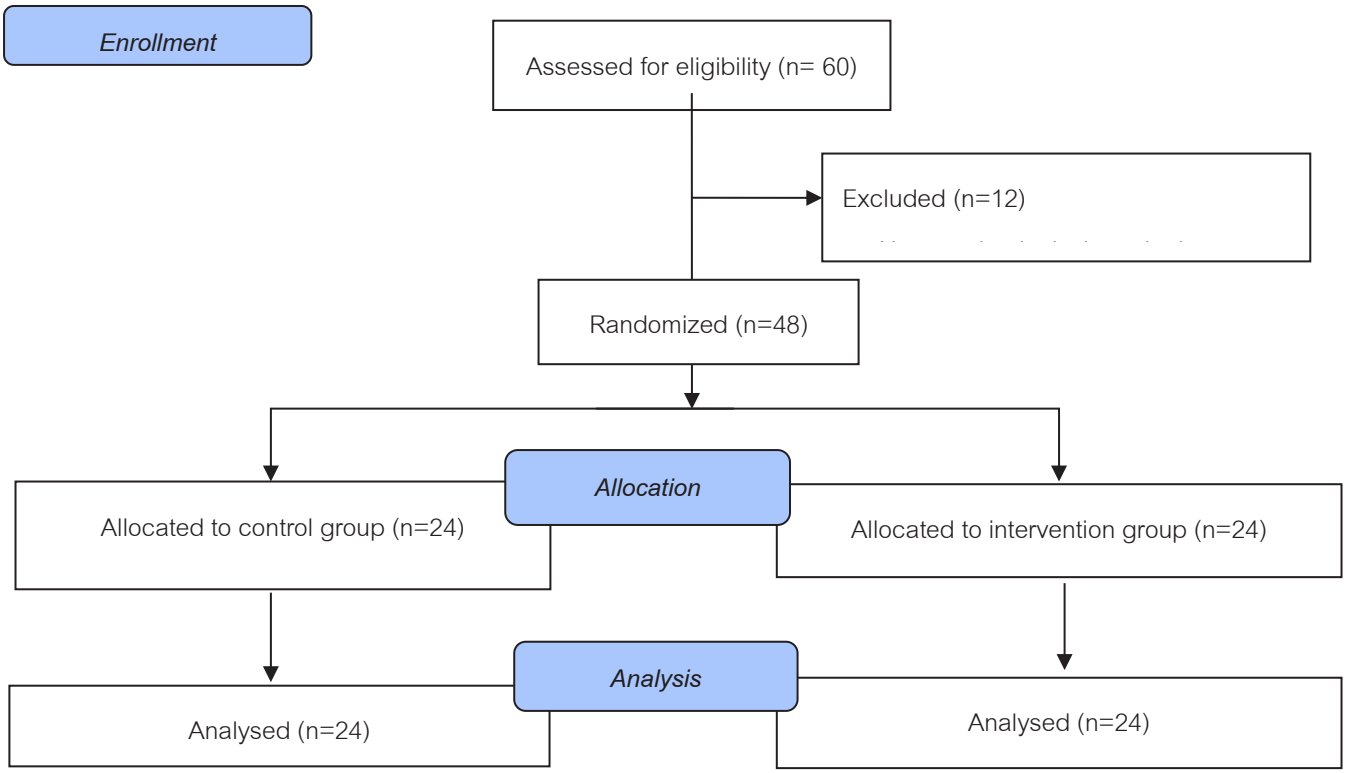


Figure 1. Flow diagram of the progress through the phases of a 2-group parallel randomized trial

INTERVENTION

The 16-week home-based training program PA, which focused on strength and balance training, was developed by physical activity experts. Participants were instructed to exercise at home for at least 30 minutes per day, 5 days per week PA. In addition, participants were asked to meet with researchers every two weeks to practice new strength and balance exercises and provide 2-3 hours of feedback on exercise and health knowledge. Strength and balance exercises included walking, balancing, cognitive function tasks, and resistance exercises taught and monitored by the researchers. Balance exercises included walking on a line and standing on one foot. Cognitive tasks included walking and arm movements in various patterns, such as walking and "right hand forward and hammer, meanwhile left hand to chest and paper," and switching, etc. Resistance exercises included resistance training with your own body weight such as squats and lunges, etc. The program is listed in the supplementary data. The number and duration of exercises were increased every two weeks until they reached 60 minutes, then participants maintained this level until the end of the intervention. Participants were instructed to record their PA exercises in the logbook each day and were reviewed and given feedback by the researchers every two weeks.

Outcome Measures

Participant characteristics including age, weight, height, body mass index (BMI), SBP, DBP, waist circumference, resting heart rate (RHR), gender, and health status were measured at baseline. Health risk factors and physical function were measured at baseline and at the end of the intervention. Health risk factors included glucose, cholesterol, triglycerides, high density lipoprotein (HDL) cholesterol, low density lipoprotein (LDL) cholesterol, and body fat. Physical function was assessed at baseline and post intervention, including balance (one-legged stand; OLS), walking ability (11-metre walk; 11mW), and lower extremity muscle performance (time up and go; TUG, and 5 times sit to stand; STS).

Blood Processing and Analysis.

Venous blood was drawn on two mornings after subjects had not eaten or drunk anything (except water) for 12 hours. It was spiked with 1.5 mg EDTA per milliliter. Aliquots of plasma were stored at -80°C for later assay of apolipoproteins. Plasma levels of total cholesterol and triglyceride were measured by enzymatic methods. HDL cholesterol was measured by dextran sulfate-magnesium precipitation, followed by enzymatic measurement of nonprecipitated cholesterol. LDL cholesterol was calculated as total cholesterol minus the sum of HDL cholesterol and VLDL cholesterol. Plasma glucose was measured by HRH Princess Maha Chakri Sirindhorn Medical Center.

Balance Assessments

One leg stand (OLS) test was used to assess balance ability. Participants were instructed to first stand on a comfortable surface, open their eyes, and support their arms at the side of their trunk, then stand on any leg without assistance. OLS was measured in seconds from the time a foot was lifted off the ground to the time it touched the ground or the standing leg, with a longer time indicating better balance ability. The OLS test has been shown to be valid and reliable [13].

Walking Ability

The eleven-meter walking test (r = 0.75- 0.90) was used to assess walking ability [14]. Participants walked on a straight walkway for 11 meters at their preferred speed (Preferred Speed Walk) on level ground and then at their maximum speed (Maximum Speed Walk). Walking at the fastest possible speed was repeated twice and the walk with the higher speed was selected as the Maximum Speed Walk. At the midpoint of the walk, approximately 3 to 8 meters from the start, the total distance and duration were measured manually [15].

Lower extremity muscle performance

Timed up and go (TUG) test, Participants were observed and timed as they stood up from a standard chair, walked 3 m at a normal pace, turned around, walked back to the chair, and sat down again. Timing, measured in seconds, began with the word "go" and ended when the subject's back touched the back of the chair, with a shorter time indicating better balance ability [16]. In the five-times stand-up test (5STS), participants were asked to stand up from a chair five times as quickly as possible with their arms crossed in front of their chest. The chair was of standard height (0.43 m) with no armrests [17]. The test is a reliable and valid test for quantifying functional mobility that may also be useful in tracking clinical changes over time [18].

Statistical analyses

SPSS version 21.0 software for Windows (SPSS, Inc, Chicago, IL) was used to perform data analysis of differences between and within groups. Results were reported with means and standard deviations for the measurements. The test for normality for the data was performed using the Shapiro-Wilk test. To assess the effects of intervention (2 levels) and time (2 times) on all dependent variables, a two-way multivariate analysis of variance (MANOVA) with repeated measures was performed. Significant interaction effects were followed up with t-tests for independent samples and t-tests for dependent samples. The significance level for all statistical analyses was set at α <.05.

RESULTS

Descriptive Statistics

The data are normally distributed. The mean age, weight, height, BMI, systolic and diastolic blood pressure, waist circumference, resting heart rate, sex, and status of participants in each group are shown in Table 1. There were no significant differences between the intervention and control groups in weight, height, BMI, systolic and diastolic blood pressure, waist circumference, and RHR at pretest (all $p > .05$), but age was a significant difference ($p < .05$). All participants reported in the logbook that they performed the exercises assigned to them in the program PA every day for sixteen weeks.

Table 1 Participants' characteristics

Variables	Intervention Group M(S.D.)	Control Group M(S.D.)	p
Age	62.44 (7.98)	57.99(6.18)	**.04**
Weight	63.05(12.77)	59.28(10.58)	.27
Height	154.12(6.01)	156.73(6.55)	.16
BMI	26.51(4.99)	26.27(2.34)	.83
SBP	150.28(15.57)	151.03(5.12)	.82
DBP	78.14(11.64)	78.48(2.88)	.89
Waist circumference	90.45(10.58)	89.84(3.79)	.79
RHR	76.25(20.19)	80.18(5.16)	.36
Gender			
-Male	3 (12.5%)	3(12.5%)	
-Female	21 (87.5%)	21(87.5%)	
Status			
-Single	0	2(8.3%)	
-Married	12(50.0%)	15(62.5%)	
-Window	7(29.2%)	3(12.5%)	
-Divorce	3(12.5%)	3(12.5%)	

Table 2. ***The intervention and time effects on dependent variables***

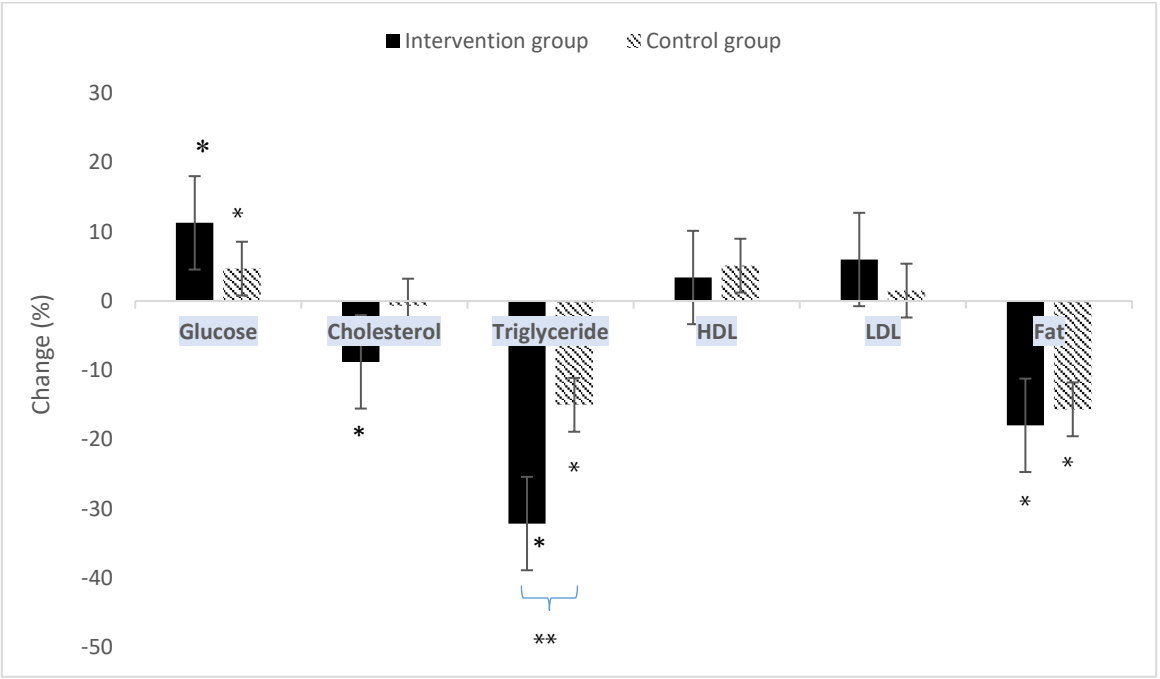
Variables	Intervention Group		Control Group		*P*
	Pre-test M(S.D.)	Post-test M(S.D.)	Pre-test M(S.D.)	Post-test M(S.D.)	Between-group
Glucose (mg)	108.67(29.74)	120.93(29.62)	112.44(7.89)	117.69(7.26)	.87
C (mg/dl)	215.67(34.24)	196.72(17.47)	204.79(14.59)	203.42(14.10)	.19
TG (mg/dl)	141.04(57.95)	95.72(10.38)	141.21(21.01)	120.04(31.84)	**.00**
HDL (mg/dl)	52.67(8.44)	54.46(5.28)	49.93(4.82)	52.48(4.81)	.21
LDL (mg/dl)	130.67(35.28)	138.51(17.62)	123.23(10.21)	125.09(11.62)	.21
Fat (%)	36.49(4.96)	29.94(3.92)	36.31(2.89)	30.63(3.58)	.52
OLS (min)	39.55(22.82)	60.28(2.70)	40.42(4.91)	49.17(11.87)	**.00**
STT (min)	10.32(3.56)	6.87(1.58)	9.75(2.25)	9.61(2.30)	**.00**
TUG (min)	7.93(1.76)	4.44(1.00)	7.43(1.38)	6.84(1.36)	**.00**
11mW (min)	3.69(.80)	3.68(.68)	3.72(.88)	3.98(.75)	**.04**

* Significant difference pretest-posttest at $p < .05$. C = cholesterol, TG = triglyceride, OLS = one leg stand, STT = sit to stand, STW = sit to walk, 11mW = 11 meters walk.

The intervention and time effects

Repeated measures MANOVA using age as a covariate showed that there was a significant interaction effect of intervention and time for all dependent variables; Wilks'Lambda F(12, .543) = .294, p <.05). Box's M test was significant F(300, 1,190.00) = 2.016, p <.05). At the pretest, there was no significant difference between the intervention and control groups on any dependent variable (all, p >.05; see Table 2 for means and standard deviations). However, at the posttest, the intervention and control groups had a significant difference in triglyceride levels, single-leg standing, sitting to standing, timed up and go, and 11-metre walking (all, p <.05), but found no difference in glucose, cholesterol, HDL, LDL levels, and percent body fat (all, p >. 05; see Figure 2).

As shown in Figure 3, the intervention significantly decreased cholesterol, triglycerides, and percent body fat and increased the ability to stand on one leg, sit and stand, time up and go, and walk 11 metres (all, p <.05), but it had no effect on HDL and LDL cholesterol levels (all, p >.05). We also found an increase in glucose levels in the intervention group (p <.05). In the control group, participants showed a significant increase in blood glucose levels and a decrease in triglycerides, percent body fat, and single leg stand (all, p <.05).



* p < .05 for the comparison with the baseline; ** p < .05 for the comparison with the control group.

Figure 2. Mean changes in health risk factors variables

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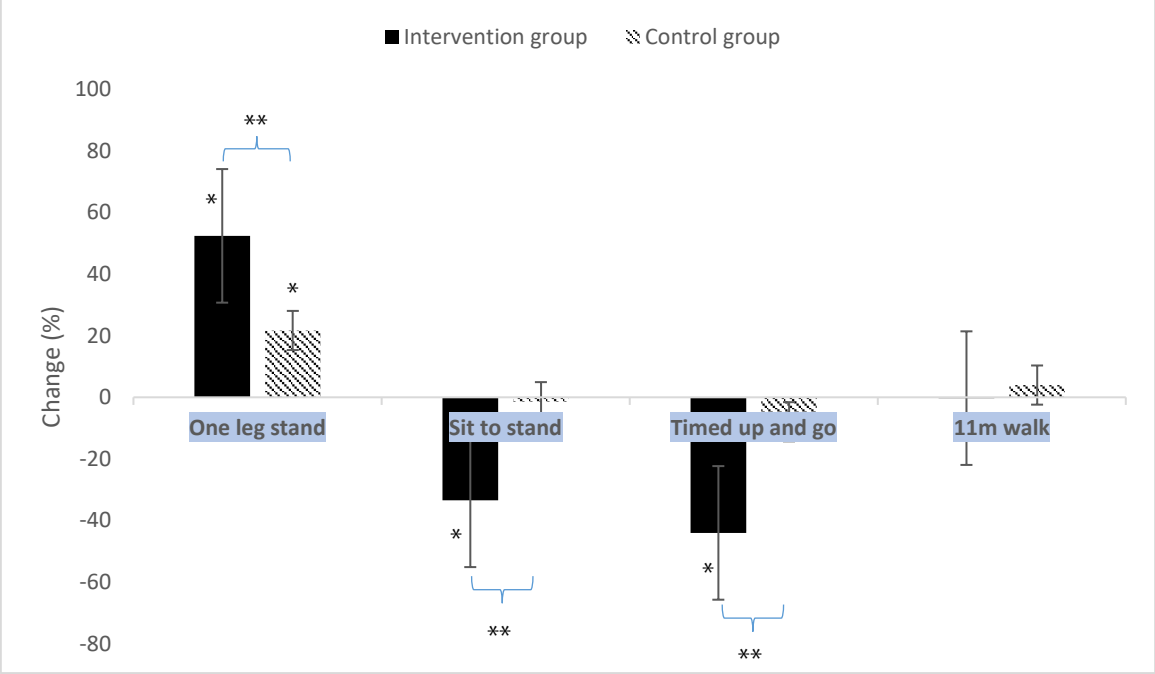

* p < .05 for the comparison with the baseline; ** p < .05 for the comparison with the control group.

Figure 3. Mean changes in physical function variables

DISCUSSION

Participants in this study volunteered for the experimental group and the control group. Therefore, the age of the participants was different. However, the researcher used the age variable as a covariate variable when analyzing the differences of other dependent variables. The main results of this study showed that the 16-week home-based strength and balance intervention could significantly improve the physical function of the elderly, including OLS (balance), STS, TUG (lower extremity muscle performance), and 11mW (walking ability), as well as triglycerides compared to the older adults in the control group. These results confirm that our intervention program focusing on strength and balance exercises, including walking, balance, cognitive tasks, and resistance exercises, had a positive impact on older adults.

The results of the current study are consistent with previous research findings that combining home-based exercise with additional group exercise programs improves fall prevention factors in the elderly [(9)]. Another study confirmed that supervised exercise intervention resulted in significant improvements in physiological factors associated with positive changes in lower limb strength [(19)]. Similar to our study, an intervention was conducted as a group activity and guided by an expert to train functional activities of daily living that require good balance and could improve carrying weights, reaching, and getting up from a chair [(20)].

Similar to previous studies, our intervention program improved balance and walking ability (TUG and OLS tests). A meta-analysis found that resistance exercise can significantly improve balance ability in adults and older adults [21]. Resistance exercise can improve performance on the TUG test [22]. An exercise program to promote balance and leg strength in women aged 65 to 89 years was able to improve skills on the TUG test[23] These studies indicated that the increase in muscle strength was related to the increase in balance ability and gait [24].

High triglyceride levels may increase the risk of heart disease. Triglycerides can diffuse into the arterial wall and accumulate, causing atherosclerosis and leading to heart disease [25]. The intervention program in our study was able to reduce triglyceride. This result follows the findings of previous studies. Kawamoto, Katoh, Ninomiya, Kumagi, Abe, and Kohara (2016) conducted a 12-week walking training program in elderly women in Japan and found that participants' triglycerides changed[26]. Similarly, Lee, Seo, and Chung examined the effects of a 12-week walking program on body composition, health-related physical fitness, and serum lipids as part of an effort to encourage middle-aged people to participate in walking as a regular and sustainable sport. They found that physical fitness was significantly increased in the exercise group, while triglyceride and LDL-C levels in the serum lipid measurement variables showed a statistically significant decrease in the exercise group [27].

CONCLUSION

The results show that home-based strength and balance intervention can be effectively delivered to improve physical function and reduce health risk factors in older people. The intervention that can improve physical function in the elderly includes OLS, STS, TUG, and 11mW, as well as some health risk factors (e.g., triglycerides).

PRACTICAL IMPLICATIONS

Older adults should be encouraged to exercise regularly to maintain muscle strength and balance. A home exercise program, facilitated by a sports scientist or exercise program specialist, can be used with older adults. Older adults can perform exercise programs independently and in the comfort of their own homes.

LIMITATIONS

The current study was subject to several limitations. First, it was not a randomized controlled trial. Another limitation was that there were few male participants in each group. Second, there was no control over

the participants' daily routine activities and nutritional status. However, participants were instructed not to change their dietary behaviors. Finally, participants had PA themselves at home, which may have been completely uncontrolled and unpracticed, although they were required to record their PA in the logbook each day.

ACKNOWLEDGEMENT

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CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest in this work.

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ภาคผนวก

โปรแกรมการออกกำลังกายเพื่อเสริมสร้างสุขภาพสำหรับผู้สูงอายุ

คำแนะนำสำหรับการออกกำลังกาย

1. ปฏิบัติวันละ 30-40 นาทีต่อวัน 5 วัน ต่อสัปดาห์ (จันทร์-ศุกร์)

2. ห้ามออกกำลังกายหลังจากรับประทานอาหารอิ่มจัด

3. เตรียมน้ำดื่มให้พร้อมขณะออกกำลังกาย

4. หากรู้สึกเหนื่อยมาก หายใจไม่ทัน เหงื่อออกมาก ตัวเย็น เจ็บที่บริเวณหัวใจหรือร้าวไปที่ไหล่ซ้าย เวียนศีรษะ ควบคุมลำตัวแขน ขา ไม่ได้ มีอาการอ่อนแรง ควรหยุดออกกำลังกายทันที

5. สวมเสื้อผ้าใส่สบายเหมาะสำหรับออกกำลังกาย ระบายอากาศได้ดี

6. ไม่ออกกำลังกายในที่ ๆ มีอากาศร้อนอบอ้าว กลางแจ้งแดดร้อนจัด หรือที่อากาศเย็นจัด

7. หากปฏิบัติกลางแจ้งต้องสวมรองเท้าสำหรับออกกำลังกาย ไม่สวมรองเท้าแตะ หรือรองเท้าที่มีพื้นลื่นไม่ยึดเกาะพื้น

8. หากปฏิบัติในร่มควรปฏิบัติบนพื้นที่ไม่ลื่น แห้ง

หมายเหตุ

การออกกำลังกายบางท่า จะมีการใช้เก้าอี้เข้ามาเป็นอุปกรณ์ดังนั้น ควรเลือกเก้าอี้ที่มีความแข็งแรง มั่นคง เพื่อให้เกิดความปลอดภัยขณะออกกำลังกาย

การออกกำลังกาย

การออกกำลังกาย	รูปแบบการออกกำลังกาย	คำอธิบาย/ความหนัก/จำนวนครั้งในการปฏิบัติ
	อบอุ่นร่างกาย/กายบริหาร/ยืดเหยียดกล้ามเนื้อ	
1. นั่งหรือยืนย่ำเท้าอยู่กับที่		ย่ำเท้าอยู่กับที่สลับซ้าย-ขวา ทำ 10 ครั้ง พัก 20 วินาที เท่ากับ 1 รอบ ปฏิบัติจำนวน 3 รอบ

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2. นั่งหรือยืนกระโดดตบ		นั่งหรือยืน กางแขนออก และยกแขนขึ้น ทำ 10 ครั้ง พัก 20 วินาที เท่ากับ 1 รอบ ปฏิบัติจำนวน 3 รอบ
3. กายบริหารบ่า		ยกบ่าขึ้น-ลง ทำ 5 ครั้ง พัก 20 วินาที เท่ากับ 1 รอบ ปฏิบัติ 2 รอบ
4. ยืดกล้ามเนื้อแขน		ประสานมือ ยืดแขนออกมาข้างหน้าจนรู้สึกตึง ค้างไว้ 15 วินาที

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5. ยืดกล้ามเนื้อขา		นั่งก้มตัวเอื้อมมือไปแตะปลายเท้าจนรู้สึกตึง ค้างไว้ 15 วินาที
6. ยืดกล้ามเนื้อคอ		เอียงคอไปฝั่งเดียวกับแขนจนรู้สึกตึง คงค้างไว้ 15 วินาที
7. เคลื่อนไหวลำตัว		หมุนลำตัวสลับซ้ายขวา 5 ครั้ง เท่ากับ 1 รอบ ปฏิบัติ 3 รอบ
การออกกำลังกายเสริมสร้างการทรงตัว		
8. ยืนขาเดียว		ยืนขาเดียวจับเก้าอี้หรือผนัง ยกข้างให้สูงจนเข่าตั้งฉาก ค้างไว้ 20 วินาที ทำสลับข้าง ซ้าย-ขวา เท่ากับ 1 รอบ ปฏิบัติ 3 รอบ
9. ยืน กางขา ชิดขา		ยืน กางขา ชิดขา ทำสลับข้าง ซ้าย-ขวา เท่ากับ 1 รอบ ปฏิบัติ 5 รอบ

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10. ยืนไขว้ขา		ไขว้ขามาด้านหน้าลำตัว ค้างไว้ 15 วินาที ทำสลับซ้าย-ขวา เท่ากับ 1 รอบ ปฏิบัติ 3 รอบ
11. เดินต่อส้นเท้า		เดินต่อส้นเท้าไป ระยะทาง 5 เมตร เดินกลับ ระยะทาง 5 เมตร หรือเดินในทางตรงระยะทาง 10 เมตร

การออกกำลังกายเสริมสร้างความแข็งแรงของกล้ามเนื้อ		
12. ปรบมือใต้เข่า		ปรบมือใต้เข่าสลับ ซ้าย-ขวา จำนวน 5 ครั้ง พัก 20 วินาที ปฏิบัติ 3 รอบ
13. นั่ง-ลุก		นั่งลุก จำนวน 5 ครั้ง พัก 20 วินาที เท่ากับ 1 รอบ ปฏิบัติ 3 รอบ

วารสารวิทยาศาสตร์และเทคโนโลยีการกีฬา ปีที่ 21 ฉบับที่ 2, ธันวาคม 2564

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14. ยืน ย่อตัว		ยืน ย่อตัว ค้างไว้ 5 วินาที ทำ 5 ครั้ง เท่ากับ 1 รอบ พัก 20 วินาที
15. ยืนเขย่งปลายเท้า		ยืนเขย่งปลายเท้า ค้างไว้ 5 วินาที ทำ 5 ครั้ง เท่ากับ 1 รอบ พัก 20 วินาที ปฏิบัติ 3 รอบ

16. กางขาสลับซ้ายขวา		เอามือจับเก้าอี้ กางขาสลับ ซ้ายขวา โดยที่ตัวไม่เอนไปด้านข้าง ทำสลับซ้าย-ขวา จำนวน 5 ครั้ง พัก 20 วินาที ปฏิบัติ 3 รอบ
17. ยกขาไปด้านหลัง		ยืนจับเก้าอี้ ยกขาไปด้านหลังค้างไว้ 5 วินาที สลับซ้าย-ขวา ทำ 5 ครั้ง เท่ากับ 1 รอบ พัก 20 วินาที ปฏิบัติ 3 รอบ