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How a Lifestyle Intervention Affects Physical Activity and Body Composition in Taiwanese Overweight Women

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Abstract: *Background: Previous studies have reported that an increased amount of physical activity (PA) can reduce obesity and hence decrease the risk of chronic diseases. However, few numbers of researches used accelerometers to investigate the association between free-living PA and health promotion. In this study, accelerometers were used to investigate how a 6-week lifestyle intervention affects PA and body composition in overweight women. Methods: Fifteen overweight women (mean age: 46.1 ± 10.3 years) in the community participated in the study. The lifestyle intervention consisted of nutrition education and complex PA training. Accelerometers and body composition analyzers were used to assess the PA and body composition in the preparatory week, and a week after intervention. Results: After the lifestyle intervention, the mean steps/day and time spent in moderate-to-vigorous intensity PA were increased significantly ($p<0.05$).The BMI, percentage of fat and fat mass of participants on the other hand were decreased significantly ($p<0.05$). However, there was no significant difference in muscle mass before and after the intervention ($p>0.05$). Conclusions: The 6-week lifestyle intervention program is a viable starting point for overweight women to initialize their daily PA. The complex physical activity contributes 50% of weight reducing in community overweight women after 6-week lifestyle intervention. It helps the change of body composition.*

Keywords: *body composition; physical activity; lifestyle intervention*

I. Introduction

The incidence of metabolic syndrome (MetS) has increased currently in Taiwan. Females were reported to have a higher prevalence percentage compared to males[1].The main causative factor attributed to MetS is obesity[2] therefore, weight control strategy plays a crucial role in MetS prevention plan. In addition to nutrient intake, weight control strategy requires lifestyle intervention and behavior changing. Moreover, the increase of daily Physical Activity (PA) is also an essential element for successful weight control[3]. Several health studies have indicated that there is a negative linear correlation between the amount of PA and prevalence of MetS[4]. Specifically, moderate (MOD)-to-vigorous (VIG) intensity physical activity (MVPA) can result in a huge expenditure of energy and changes of physical fitness[5]. Thus, MVPA promotion is a necessary objective of public health organization [6]. A Previous research has found that increasing PA may reduce obesity and decrease type 2 diabetes even if the exercise intensity was only from low to MOD intensity level. This finding may explain why the level of PA and the amount of PA have a positive correlation to health and physical fitness. In Taiwan, with the high economic development, most women spend their time on profession and family, thus they are more likely to have inactive and sedentary lifestyle. They tend to have a myth that PA during daytime working tasks are enough to reach ACSM-AHA PA recommendations. In addition, women may encounter greater risk of inactivity and become overweight because of biological, psychological and behavioral transitions during menopause. Further research on how to establish an effective physical activity program for overweight women is therefore needed.

To date, structured or unstructured (focuses on lifestyle changes and encourages participants to increase PA by daily lifestyle activity skills) physical exercise interventions are generally used to promote PA. In fact, both structured and unstructured physical exercises have positive effects on increasing the amount of PA and decreasing the risk of type 2 diabetes [7, 8]. Koort *et al*.[9] reported that PA intervention could be more effective when it is targeted at specific activities. In addition, the increase of lifestyle activity intervention is easy to implement without time and space limitations therefore, it is a priority strategy to improve PA on sedentary individuals or the aging population. Several studies have reported that regular physical activity, and frequent contact health professionals can changes body composition in a better way [10, 11]. A one-year follow-up study conducted by Schaefer *et al*. [12] reported that lifestyle intervention was effective to reduce the degree of overweight, fat mass, blood pressure and waist circumference at the end of the intervention and in 12 months follow-up period [12]. However, there is little research focusing on low intensity (LI) lifestyle activity and its effectiveness during intervention program with participants [4, 13]. One of the main reasons is that it lacks PA changing assessment of participants during the process of PA intervention. Particularly, it becomes more difficult when PA changing assessment is focusing on LIPA besides the amount of structured physical exercise in the course. During the intervention program, experts assessed the amount of structured physical exercise, but after the end of the structured intervention, the amount of LIPA was unclear. In this case, it is necessary to investigate the effects of different levels of PA in a lifestyle intervention on body composition in order to enhance a better understanding of the association between PA and health promotion. Patrick [14] reported that physical activity are important behaviors for general population to achieve a successful weight loss outcome.

With the advent of many personalized motion detecting devices, such as pedometers and accelerometers, these devices were widely used to investigate the relationships between daily PA and health outcomes[15]. However, many reports have indicated that accelerometers are more suitable in investigating the level of daily PA[16, 17], but it can only provide the PA information of MVPA and not LIPA or sedentary behavior. Therefore, many investigation reports only focused on MVPA data analysis and discussion. Recently, a relatively new and commonly used activity monitor, the Kenz Lifecorder EX (KL, Suzuken CO. Ltd, Nagoya, Japan) is been introduced. KL is a personalized movement-detecting device developed by Japan, which has pedometer and accelerometer features in one. Schneider *et al*.[18] in their research reported that KL can record daily-step counts and the time spent in activities according to the intensity levels (LI, MOD, VIG) [18]. Thus, it is a suitable activity monitor for free-living lifestyle intervention with PA evaluation.

The purpose of this study was to employ KL to investigate lifestyle intervention effects on body composition and PA in community of overweight women, including the information of daily-step counts and the time spent in MVPA. Data were collected and analyzed in order investigate the association of lifestyle intervention with PA promotion and body composition. The findings presented the mechanisms of lifestyle intervention with body composition and PA. Moreover, they also indicated that a 6-week lifestyle intervention is effective on PA and body composition. Finally, the study provided a viable starting point for overweight women to initialize their daily PA.

II. Methods/Design

1. Participants

The participants in this study were from community weight reduce program organized by community hospital in WanHwa district, Taipei. All study procedures were informed and written consent was obtained from all participants. (project approval number: EHS-PC-095-005). However, the inclusion of participants in this study was limited to adult females with a body mass index (BMI, weight/height^2) $\geqq$ 24 kg/m^2. The intervention course was held every Tuesday night without any charge but registration in advance was needed. 15 overweight women were eligible for the study and were surveyed by the community hospital. Among the 15 participants, there were 4 housewives and 11 part-time or full-time professional women. 10 of 15 were postmenopausal or had irregular menstrual cycle, 12 of 15 had high blood pressure, diabetes or hypercholesterolemia. Demographic data, which were acquired with a structured questionnaire and body composition, were measured by a body composition analyzer (Inbody model 720, Biospace Co. Ltd, Seoul, Korea). This analyzer measured the body height, body weight, BMI, waist to-hip ratio, percentage of fat (Fat %), fat mass and muscle mass before lifestyle intervention program begins. Also, systolic (SBP) and diastolic blood pressures (DBP), blood lipid analysis and fasting glucose were measured. Table 1 illustrated the demographic and health characteristics of participants.

The purpose of the lifestyle intervention program was to help participants learn the causes of overweight and the negative effects it has on health. Moreover, it aimed to help participants to develop strategies to combat their unhealthy situations, and to motivate them to participate in lifestyle interventions. Furthermore, it encouraged participants to change dietary habits and PA in order to reach the goal of weight reduction and to achieve health promotion. The current study measured PA and body composition before and after the intervention in order to have more understanding of the beneficial effects of lifestyle intervention in overweight women. The lifestyle intervention was targeted on thorough lifestyle changing to increase daily PA. Specifically, the study encouraged participants to increase daily step counts and PA intensity by brisk walking.

Table 1 Demographic and Health Characteristics of Participants

Variables	Sample (n)	Percentage (%)
Occupation		
Housewife	4	27%
Full time / Part time professional women	11	73%
Menstrual cycle		
Regular	5	33%
Irregular	6	40%

Postmenopausal	4	27%
Chronic Diseases		
Noun	10	67%
Yes	5	33%
High blood pressure	3	
Diabetes	1	
Others	3	
Health Variables	**Values (Ranges)**	
Age (yrs)	46.1 ± 10.3 (25-64)	
Height (cm)	157.2 ± 5.5 (153-173)	
Systolic blood pressure (mmHg)	134.5 ± 24.4 (94-191)	
Diastolic blood pressure (mmHg)	83.3 ± 11.7 (64-106)	
Fasting blood sugar (mg/dl)	79.6 ± 12.2 (65-114)	
Total cholesterol (mg/dl)	207.3 ± 43.7 (157-278)	
Triglyceride)md/dl)	111.4 ± 76.8 (51-299)	

Values presented as "mean ± standard deviation"

2. Lifestyle Intervention

Numerous studies have indicated that combined effects of diet and exercise are superior to only diet or exercise in terms of weight loss [19]. The lifestyle intervention in the current study however consisted of nutritional education and a complex PA training which took place once a week (1 hour per session) throughout the 6-week intervention period. A family medicine physician and a licensed dietician introduced the former, which included nutritional knowledge and behavior, weight loss and medical concepts. The latter was taught by a professional exercise physiologist in which complex PA training was based on PA promotion courses including sporting knowledge, correct walking methods, concept of brisk walking, the use of towel, dumbbell, chair and floor to do living resistance training (see Figure1).

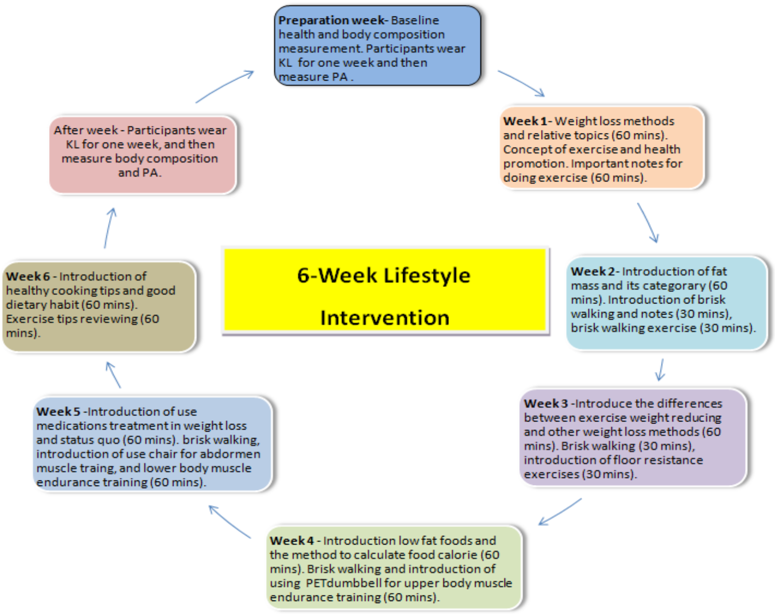

Fig 1. A 6-week Lifestyle Intervention Programme Content

3. PA Measurements

The accelerometer used in the study was KenzLifecorder EX (KL); KL is a built-in uniaxial accelerometer with size of *7.0* (length)X*4.0* (height) X *2.5* (width) cm. It can measure the intensity of vertical body movement (activity Intensity Level) during 4 seconds sampling periods and uses this acceleration value to classify the intensity of movement. KL is able to sample vertical accelerations that range from 0.06G to 1.94G[20]. In addition, KL according to activity intensity measurements is used to calculate caloric expenditure and basal metabolic energy expenditure based on age, gender, height and weight. McClain *et al*.[20]reported that the signal of activity is filtered by an analogue band pass and digitalized. Once the maximum pulse is over 4 seconds, it is recorded as the acceleration value. According to the acceleration value, KL categories the movement into one of 11 intensity (0, 0.5, and 1-9). Level 0 corresponds to acceleration values less than 0.06G (no detected acceleration, i.e., sedentary state, no detectable signal). Level 0.5 (micro-activity) represents that an acceleration signal was detected, but less than 3 pulses were detected during the 4sec sampling interval. (ie. sitting upright, change position, taking transportation tools). Levels 1-9 were used to categorize intensities that were reflective of increased number and magnitude of pulses. Level 1-3 indicate LOW intensity PA, level 4-6 represent MOD intensity PA, and level 7-9 indicate VIG intensity PA [21].The features of KL are similar to ActiGraph (AG: Actigraph LLC, Fort Walton Beach, FL), which is been wide used for physical activity research. In 2009, ActiGraph released the triaxial GT3X activity monitor, it measures acceleration in VT, AP and Medio-lateral(ML) three individual orthogonal planes. The activity counts are measured and presented as a composite vector magnitude of three axes. Figure 2 shows the KL output example of a daily activity. Physical activities were detected and recorded into different intensive level according to the acceleration value. The KL records daily activity in 24 hours interval, and accumulates the intensive level of physical activity.

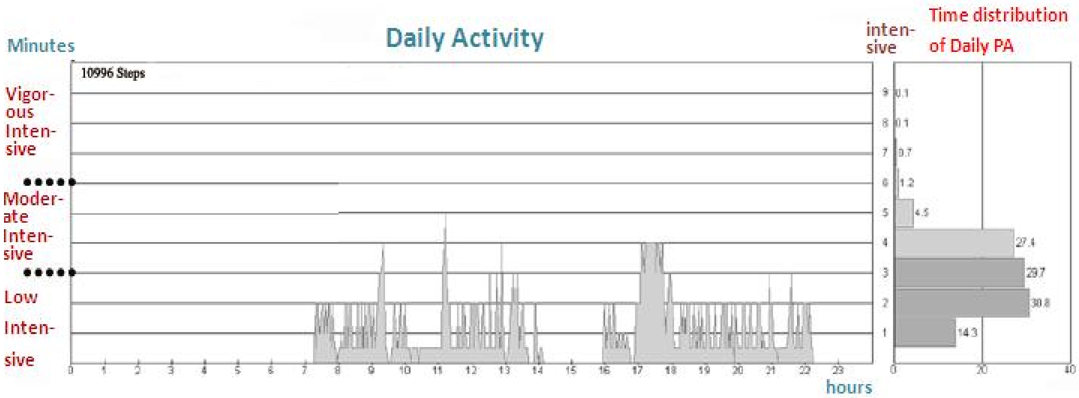

Fig 2. KL output example of daily physical activity

Besides KL and ActiGraph, there are several accelerometers on the market such as MEMS LIS2HH12, activPAL3z, LSM303C, ADXL335 and MMA8452Q. Many previous literatures have supported the feasibility and validity of KL in measuring the different intensive levels of physical activities in daily life. For example, Abel *et al*. [40] examined the validation of the Kenz Lifecorder EX and AntiGraph GT1M accelerometers in 2008, they validate step count, activity energy expenditure (EE) and total EE output from the KL and AG. The study reported that at the treadmill speeds both activity monitors underscored. The KL underestimated activity energy expenditure (EE) at faster running speeds and underestimated total EE at some running speeds, and overestimated total EE at some walking speeds.

4. Procedure

Upon the beginning of intervention, and besides the date of intervention, the demographic information of the participants were recorded into KL, including height, weight, age and gender. The participants were fitted a KL with an elastic belt worn at the waistline and were given instructions to wear KL every day during all walking hours (except for showering and water activity). Since KL can automatically date adjustment, record and accumulates PA continuously, participants needed not to do any setting or adjustment. In order to obtain normal and correct data, the increase of PA purposely by the participants was avoided as they did not learn how to do any adjustment or check their PA record.

The participants wore their KL for one week before the intervention program began, and one-week after it ended. Before the participants returned their KL they also completed a brief exit interview to report any incident during scheduled monitoring period. The collected PA data were refined, organized and analyzed by PA analysis software (version 1.0, SuzukenCo.Ltd, Nagoya, Japan). Trost, Mclver and Pate[22] have suggested that for daily activity, analyzed research needs to collect at least 3 to 5 consecutive days PA data. Another study conducted by Netwon*et al.* demonstrated that a single 3-day monitoring period did not differ significantly over 4-6 months[23]. Therefore, this study collected 3 to 5 days PA data of participants twice (before and one week after end of intervention program) for analysis. The PA data included average daily step counts (steps/day), average PA time spent and classifications such as the time spent in LI PA, MOD PA and VIG PA.

5. Statistical Analysis

In this study, the analysis focused on the tracking of free-living PA by accelerometer. Therefore, valid data must include two assessment occasions, defined as having 3 consecutive days of accelerometer data. All data analysis were carried out using SPSS version 17.0 software (SPSS, Inc., Chicago, IL, USA). All body composition variables (i.e. age, height, weight, BMI, Fat%, fat mass, muscle mass) and PA associated data (i.e.

steps/day, time spent in active PA) were tested by Kolmogorov-Smirnov test to examine for normal distribution. The Data were calculated and presented as mean and standard deviation. All statistical tests were two tailed and significant tests were on an alpha=0.05 level. In order to achieve the study purpose, a paired t-test was done to investigate the differences between before and after the end of the intervention.

III. Results

Table 1 presents the descriptive characteristics of participants. Kolmogorov-Smirnov test showed that physical characteristics and body composition were normally distributed. One week after the end of intervention, the weight, BMI, Fat%, and fat mass of participants were 70.2 ± 12.1 kg, 28.4 ± 4.7 kg/m^2, 38.4 ± 4.6%, 27.3 ± 7.8 kg, respectively (see Figure 3).

Table 2 Body composition, Physical Activity Before and After a 6-week Lifestyle Intervention.

Variables	**Before (MN ± SDV)**	**After (MN ± SDV)**	**Change**	***P* value**
Body Composition				
Weight (Kg)	71.9 ± 13.5	70.2 ± 12.1	-1.7 ± 2.6	<.05
BMI (Kg/m^2)	29.0 ± 5.2	28.4 ± 4.7	-.6 ± 1.0	<.05
Body Fat (Kg)	29.1 ± 8.7	27.3 ± 7.8	-1.7 ± 1.8	<.05
Muscle mass (Kg)	40.4 ± 5.5	40.5 ± 5.2	.0 ± 1.2	<.05
Body fat (%)	39.9 ± 4.5	38.4 ± 4.6	-1.5 ± 1.3	<.05
Physical Activity				
Mean steps (day)	7,826 ± 2,473	10,697 ± 3,817	2,871 ± 3,946	<.05
Mean sleeping time(minutes/day)	653.9 ± 126.5	627.4 ± 104.9	-26.4 ± 107.8	NS
Mean sedentary time(minutes/day)	700.8 ± 123.0	699.6 ± 108.4	-1.2 ± 92.2	NS
Mean active time Spent in PA (minutes/day)	85.3 ± 26.7	112.9 ± 37.1	27.6 ± 39.9	<.05
Low (LI)	69.1 ± 23.3	80.7 ± 23.8	11.6 ± 28.2	NS
Moderate (MOD)	14.6 ± 6.9	30.4 ± 24.0	15.9 ±22.0	<.05
Vigorous (VIG)	1.7 ± 1.6	1.8 ±1.6	.1 ±1.5	NS

Abbreviations: BFI, before intervention; MN, mean; SDV, standard deviation; AFI, after intervention; NS, no significant differences; LI, low intensity; MOD, moderate intensity; VIG, vigorous intensity

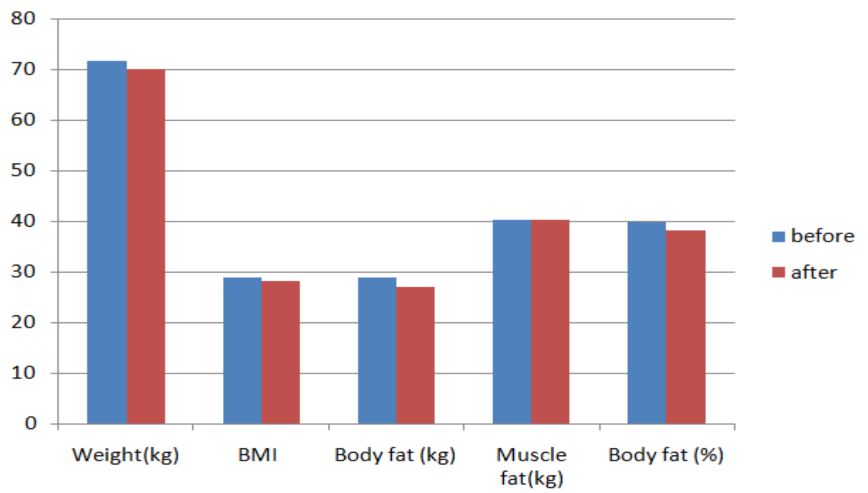

Fig 3. Body composition of particpants before and after a 6-week lifestyleintervention

A paired t-test indicated that the participants reduced their degree of overweight, besides the BMI, Fat%, fat mass were decreased significantly one week after the end of intervention when compared to the data before intervention (P< .05).However, comparative data showed no significance differences in muscle mass before and one week after the end of intervention (*P*> .05) (see Table 2). Furthermore, there were significant differences before and one week after end of intervention for daily step counts (7,826 ± 2,473 vs. 10,697 ± 3,817 step), average daily accumulated time spent in PA (85.3 ± 26.7 vs. 112.9 ± 37.1 min) and the average of daily time spent in MVPA (14.6 ± 6.9 vs. 30.4 ± 24.0 min). Figure 4 shows the average daily accumulated time spent in PA (85.3 ± 26.7 mins vs. 112.9 ± 37.1 mins) and the average time spent in different intensive PA before and after the intervention.

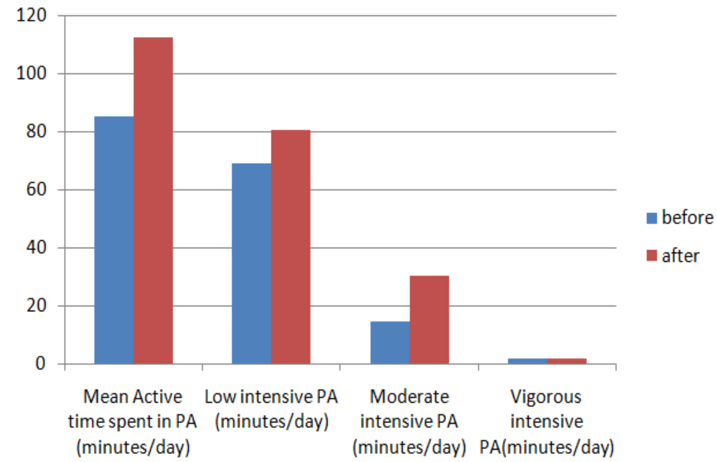

Fig 4. Average daily accumulated time spent in PA

IV. Discussion

Obesity has been one of the main factors that causes MetS[2]. Many studies have reported that it is also the cause of many chronic diseases, such as cardiovascular disease, diabetes, and certain cancers. Therefore, weight control becomes very crucial in building a healthy community. In this weight loss project, apart from the changes in dietary habits, the promotion of PA is also an important factor needed to put into consideration [12]. Unstructured lifestyle intervention focuses on free-living activity as it can eliminate the time and space limitations of exercise and can achieve the goal of PA promotion as structured exercise does. Therefore, it effectively encourages community people to begin their first step to do exercise, thus increasing their PA [24]. This lifestyle intervention can therefore enable people to overcome the problems of obesity and decrease the prevalence of MetS in community. A research by Peng [11] and many researches [39] revealed that in addition to the introduction of knowledge associated with nutrient intake, PA promotion has a significant impact on Fat% in community overweight participants one week after the end of intervention. However, it is still unclear in terms of the changing of PA during the intervention. This study demonstrated this by the used of validated and reliable physical monitor KL to investigate the changing of PA during lifestyle intervention, and found that lifestyle intervention was effective in reducing the degree of overweight and improving body composition of community participants.

Before intervention began in the study, the average Fat% of participants and the BM1 were 39.9 ± 4.5%, and 29.0 ± 5.2 kg/m^2, respectively. These were classified into obesity group according to body composition classification. After 6-week lifestyle intervention, comparative data showed that the condition of muscle mass remained unchanged, the weight, BMI, Fat% and fat mass were decreased significantly (P<.05). This indicated that the lifestyle intervention effectively reduced the degree of overweight by decreasing fat mass. The possible reason for this finding besides brisk walking and other aerobic exercise could be because the PA program encouraged participants to used PET (Polyethylene Terephthalate) bottle as dumb-bell and floor to do resistance training. A study conducted by Rachel[25] pointed out that future studies should emphasis on measuring body Fat% instead of body weight or BMI since body fat mass is the most metabolically harmful tissue type. Another research conducted by Donnelly *et al*. [7, 26] indicated that resistance training effectively reduces the degree of overweight and the risk to health. Moreover, the investigation reported that PA intervention can prevent muscle mass reduction while the weight reduces. This showed the potential advantage of combined lifestyle intervention, which included nutrient intake, and exercise of weight control. Ameneh and other researchers found that undertaken fewer session longer duration PA is more effective for weight loss compared to undertaken more frequent but shorter sessions on a women weight loss program[27]

The analyses of PA investigation data showed that the participants in the current study took an average of 7,826 steps/day before intervention began. This was consistent with the investigation of Japanese adult women daily step counts 7,902 steps/day[28]. Many data revealed that the average steps/day for the participants in the current study was indicated at the level of somewhat active (7,500-9,999 steps/day) group, which may be associated with about 73% of participants of either the professional or the part time workers. After 6-weeks lifestyle intervention program, the average daily step count was significantly increased to the average of 10,697 steps/day (with 2,871 steps/day increment) (P <.05). The result not only reached the current ACSM-AHA PA recommendations (10,000 steps/day) but also brought the participants to the level of active. Jonghoon et al., [29] demonstrated that BMI correlated with the number of steps and time spent in moderate-intensity PA negatively. Furthermore, body Fat% showed a negative relationship with PA level and PA-related energy expenditure (PAEE)/body weight (BW). This may explain the effectiveness of lifestyle intervention in PA promotion by average steps/day as indicated. Another released study by Bravata *et al*.[30] reported that in an 8 randomized control groups with 155 participants (85% female, mean age: 49 years) intervention research, the average steps/day increment of participants was 2,491 steps/day with significantly decreased of BMI.In addition, the average daily time spent in PA for participants was used as an indicative measure of PA promotion. Before intervention began in the study, the participants' average daily time spent in MVPA was 14.6 min (Table 2). This data revealed that the average daily time spent in MVPA was lower than ACSM-AHA recommendation of average daily time spent in MVPA (30 min)[31]. However, the result was consistent with a previous study conducted by Tomoko, Atsumi and Ayu[32] . In their research, there were 34 participants (age: ≧ 60 yrs; BMI: ≧ 25 kg/m^2) in which each wore an accelerometer for 14 days to investigate average daily time spent in MVPA; the results were 15.8 ± 10.1 min. Besides, the average time spent in LI PA of the participants in the current study, this value was higher compared to the study conducted by Yamauchi, Koide and Muto (69.1 min vs. 38.9 ± 14.4 min)[32]. However, the accumulated time spent in active PA of participants in the current research was much higher than the study of Yamauchi, Koide and Muto (85.3 min vs. 57.6 min). It is possible that the participants in this study were younger with an average age at 46.1 years compared to an average age ≧ 60 yrs, and most of them were part time or professional women.

After a 6-week lifestyle intervention, the accumulated time spent in active PA in overweight women was significantly increased by 28 min ($p< .05$). This showed that lifestyle intervention has positive effects on overweight women with the respect of daily living PA. Moreover, the average daily time spent in MVPA of participants after lifestyle intervention was 32 min. This not only showed 18 min significant increment ($p<.05$) before lifestyle intervention but also reached the recommendation of ACSM. The statistical data in the study therefore presented that lifestyle intervention has an association with daily time spent in MVPA and daily step counts. ACSM reported that obese or overweight adults have to engage 150 min in MVPA per week to improve health condition[26] . For those who preferred to have weight loss continuous weight loss should at least engage 200-300 min in MVPA per week. However, in this study, the participants had 210 min time spent in MVPA, leading to significant decrease in body weight. From the results of this study, there are two possible reasons for improvement of daily step counts and daily spent time in MVPA. First, this study encouraged participants to engage in brisk walking and any style of free-living PA. Secondly, the participants in the study had a high positive attitude to engage in lifestyle intervention in order to achieve health promotion[33]. Therefore, they were willing to follow the nutritional knowledge instructions from dietician and physician to change dietary habit and engage in daily PA[34]. Previous studies from Yamamoto and his colleagues[35] showed that when the steps/day was≧ 10,000, the daily time spent in MVPA was extended relatively thus incurring the decrease of body fat. It may also imply that the change of body composition of participants in the study could be due to the increase of the time spent in MVPA, which must have increased caloric expenditure. Many studies [36, 37] indicated that the increment of 2,000 steps/day consumed 100-150 Kcal and the value of calorie equivalent of weight was 7,000 Kcal/kg. The average increment daily step count of the participants in the current study was 2,800 steps/day. The total caloric expenditure of the 6-week intervention was around 5,880 Kcal (2,800 steps x 42 days/2,000 steps x 100 Kcal) causing a decrement of about 0.8 kg of body weight. From the aspect of energy balance, both dietary habits and PA play a significant role in health promotion [38] .

V. Conclusion

The findings from the current study underlined the potential benefits of a 6-week lifestyle intervention on health promotion by increasing PA in daily life and it helps the change of body composition. This is very significant because limited studies utilized accelerometer to monitor free-living PA and reported the association of different levels of daily PA with health promotion. The strength of the current study was the used of accelerometer to monitor free-living PA and found that the average daily time spent in MVPA of the participants significantly increased. Furthermore, current study examines the change of physical activity and show how it affects body composition based on daily step count perspective. From this stand, we may estimate the contribution nutritional education to the change of body composition. These findings offer valuable insight into the development of health promotion strategy by increasing PA and changing the body composition of the people in the community.

VI. Research Limitation

One limitation of this study was the relatively small sample size of participants. The findings may not be applicable to various communities and groups as the intervention program was limited to overweight women residing in WanHwa district. Future research is required to recruit more participants and observe the differences of gender and groups of participants to decrease the risk of statistical violations. A second limitation of this study was that even the findings from this investigation showed that intervention program helps the change of PA and body composition, it still lacks evidence to clarify that the changes of body composition was due to the change of dietary intake or PA promotion alone, or from both. It is necessary to have the design of control group for the investigation of relation between changes in diet and or physical activity on body composition in future research.

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