Circuit exercise combined with stages of change theory on body composition, exercise behavior and quality of life in working women

Ejercicio en circuito combinado con la teoría de las etapas del cambio sobre la composición corporal, el comportamiento de ejercicio y la calidad de vida en mujeres trabajadoras

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Abstract

Introduction: The problem encountered when entering working-age women is low physical activity, resulting in being overweight.
Objective: This study aimed to examine and compare the effectiveness of a circuit exercise program combined with the stages of change theory on body composition, exercise behavior, and quality of life among overweight working-age women.
Methodology: Twenty-nine overweight working-age women were divided into 2 groups: 1) circuit exercise program combined with the stages of change theory (EXP; n = 15), and 2) control group (CON; n = 14). The research instruments included a body composition test, an exercise behavior questionnaire, and a quality of life questionnaire, which were measured pre-test, post-test (Week 12), and following a 24-week training period.
Results: The body composition changes when comparing pre-test and post-test; the EXP group's body weight, BMI, body fat percentage, muscle mass, and visceral fat mass were significantly different from those of the CON group ($p<.05$). Similarly, the mean scores of exercise behavior at the post-test and the follow-up were different between the groups. In particular, in the EXP group, there was a better change in the mean score of quality of life in all dimensions when compared to the pre-test, the post-test, and the 24-week follow-up period.
Conclusions: The circuit exercise program combined with the stages of change theory can be used to induce behavior change, provide support and encouragement, and learn to perform the program until it becomes an action step.

Keywords

Body composition; circuit exercise; exercise behavior; quality of life; stage of change theory.

Resumen

Introducción: El problema que enfrentan las mujeres en edad laboral es la baja actividad física, lo que resulta en sobrepeso.
Objetivo: Este estudio tuvo como objetivo examinar y comparar la eficacia de un programa de ejercicio en circuito combinado con la teoría de las etapas del cambio sobre la composición corporal, el comportamiento de ejercicio y la calidad de vida en mujeres con sobrepeso en edad laboral.
Metodología: Veintinueve mujeres con sobrepeso en edad laboral fueron divididas en 2 grupos: 1) un programa de ejercicio en circuito combinado con la teoría de las etapas del cambio (EXP; n = 15), y 2) grupo de control (CON; n = 14). Los instrumentos de investigación incluyeron una prueba de composición corporal, un cuestionario sobre el comportamiento de ejercicio y un cuestionario sobre la calidad de vida, los cuales se aplicaron en la prueba previa, la prueba posterior (semana 12) y después de un período de entrenamiento de 24 semanas.
Resultados: Los cambios en la composición corporal al comparar la prueba previa y la prueba posterior mostraron que el peso corporal, el IMC, el porcentaje de grasa corporal, la masa muscular y la grasa visceral del grupo EXP fueron significativamente diferentes a los del grupo CON ($p<.05$). De igual manera, las puntuaciones medias del comportamiento de ejercicio en la prueba posterior y el seguimiento también fueron diferentes entre los grupos. En particular, en el grupo EXP se observó una mejora en la puntuación media de la calidad de vida en todas las dimensiones, al compararla con la prueba previa, la prueba posterior y el seguimiento a las 24 semanas.
Conclusiones: El programa de ejercicio en circuito combinado con la teoría de las etapas del cambio puede utilizarse para inducir un cambio de comportamiento, proporcionar apoyo y motivación, y aprender a realizar el programa hasta que se convierta en una acción habitual.
finalizar con conclusiones más sobresalientes.

Palabras clave

Composición corporal; ejercicio en circuito; comportamiento de ejercicio; calidad de vida; teoría de las etapas del cambio.

Introduction

In adulthood, decrease in muscle mass and abnormalities in fat tissues are commonly found, affecting the energy metabolism efficiency and leading to various non-communicable diseases (NCDs) (Bosy-Westphal & Müller, 2021). In addition, the prevalence of overweight and obesity in the age range of 20-44 years is more common in males. However, in the age range of 45-49 years, the prevalence is more common in females than males (Chooi et al., 2019), especially in working-age women with low physical inactivity, lack of care and attention to health behaviors, resulting in the risk of developing many diseases and affecting the overall quality of life (Guh et al., 2009).

Circuit exercise is a type of training that can improve muscle strength, maximal oxygen consumption (VO2max or cardiovascular endurance) (Turri-Silva et al., 2021; Yuniana et al., 2024), speed, agility (Yunus et al., 2024), and lung function (Rifki et al., 2023). It involves a sequence of exercises that use major muscle groups, repetitions of exercises (*10-20* repetitions/exercise), duration of training between exercises and circuits, and rest between sets, as well as exercise designs that alternate muscle groups during exercise (Muñoz-Martínez et al., 2017). Training duration of approximately *50* minutes/day, *3* days/week can improve physical fitness (Bocalini et al., 2012). Training intensity can be measured by heart rate and training volume (Marcos-Pardo et al., 2019; Su et al., 2019). Moderate-intensity training reduces the rate of dropout and allows for better completion of the planned program than high-intensity training (Perri et al., 2002). Especially, moderate-intensity circuit exercise can improve physical fitness in terms of body composition, muscle strength and endurance, and VO2max (Irene-Chrysovalanto et al., 2021; Marcos-Pardo et al., 2019; Namboonlue et al., 2024), and significantly reduce inflammation and cell damage compared to high-intensity training (Cerqueira et al., 2020). Therefore, moderate-intensity circuit exercise is as effective in improving physical fitness and increasing metabolic rate as high-intensity training. It is also safe, timesaving, and uses less exercise equipment. It can also help reduce the risk of injuries to tendons, joints, and muscles, and is suitable for working-age women. Moreover, it is necessary to build an understanding of the concept and theory of health promotion and holistic disease prevention as they are important factors influencing the development of behavioral practices to promote health. The theory that can be most effective among overweight working-age women is the stages of change model.

The stages of change model (Marcus & Simkin, 1994) is a widely used theory that describes how to modify individual behavior to promote health, particularly exercise behavior. It involves studying individual behavior to observe changes in health. Intention and continuous effort are required for behavior change. Each individual must perceive his or her self-efficacy and recognize the benefits of behavior change by learning from various sources of information and media to change the behavior. Individual behavior can be divided into 5 stages: precontemplation, contemplation, preparation, action and maintenance. The application of the stages of change theory is to classify people according to the differences in their changes in each stage of behavior change. The stages of change of each individual will be assessed so that activities can be appropriately organized to match the individuals in each stage. Also, social support will stimulate behavior change. If these steps are followed, sustainable behavior change will occur (Marcus & Simkin, 1994), which will then influence the change planning. Understanding individual motivations will help to effectively plan stimulus interventions and tend to result in positive or sustained change over the long term (Esch, 2018). The experience of receiving positive change can create satisfaction and a good feeling, and applying feedback or planning rewards for positive change can maintain the behavior in the long run (Michaelsen & Esch, 2021). Therefore, controlling and preventing overweight must be done correctly. Exercise is important. When people have appropriate health behaviors, they will be healthy. Having appropriate exercise behaviors will result in a good quality of life. This study aims to examine the effectiveness of a moderate-intensity circuit exercise program combined with the stages of change theory on body composition, exercise behavior, and quality of life among overweight working-age women.

Method

Study Design

This was quasi-experimental research. The inclusion criteria were as follows: overweight working-age women with a body mass index of *25.0-29.0* kg/m*2*; aged *30-59* years; staff of Ubon Ratchathani Rajabhat University, including lecturers, civil servants, government employees, permanent employees, and temporary employees in the academic year *2023*, and outsiders receiving services at UBRU Fitness from March to November *2023* who were overweight working-age women with the exercise behavior level of being ready to do exercise; not exercising regularly or exercising less than 3 days per week, and being healthy and free from diseases or symptoms making them unprepared to exercise, as assessed by the Physical Activity Readiness Questionnaire (PAR-Q). The exclusion criteria included having injuries to muscles, bones, tendons, joints, or other diseases such as heart disease and high blood pressure and participating in the project less than 80% of the specified period. The study was approved by Ubon Ratchathani Rajabhat University Human Ethics Committee (HE662039).

Participants

The sample size was calculated using the G*Power program. Weight was used for the sample size calculation (Chuensiri et al., 2018). The power of the test was set at *0.95*. The effect size was at set *1.38*. The significance level was set at *0.05.* There were *24* participants, recruited by a simple random sampling method and divided into *2* groups: the experimental group (EXP) of *12* people and the control group (CON) of *12* people. To prevent the drop out of the participants during the research process, an additional sample of 20% was calculated, which was 6 people. Therefore, there were 30 participants (15 people per group). During the research process, 1 person in the CON group was injured and withdrew from the research project. As a result, there were 29 participants: 15 people in the EXP group and 14 people in the CON group. Data on the variables were collected before, during and after the experiment in both groups. The research period was 24 weeks, from December 2023 to May 2024, with the following procedures.

Procedure

Experimental Group (EXP)

The EXP group received a moderate-intensity circuit exercise program together with the application of the stages of change theory. The EXP group was asked to participate in the program at UBRU Fitness, which provided a specific room for the activities included in the program in the Class Exercise Room. The activities in each week were as follows.

1. Week *1 (2* hours): The purposes and procedures of the research, the benefits to be gained, and the application of the research results were informed to the participants. The participants' BMI, body fat percentage, and muscle mass were measured and used as the criteria for setting short-term goals. Data were collected on changes in exercise behavior levels, exercise behavior, and quality of life of the participants.
2. Week *2 (2* hours) (Preparation): The activities included providing information about exercise, presenting health care models, holding group discussions to compare the advantages and disadvantages of exercise, demonstrating correct exercise, practicing exercise skills, encouraging the participants to exercise by forming groups, setting goals, and committing to participate in the research project.
3. Week *3*-4 *(2* hours) (Action): The activities were organized by providing information about exercise, presenting models, holding group discussions to compare advantages and disadvantages of exercise, demonstrating correct exercise, practicing exercise skills, encouraging the participants to exercise by forming groups, setting goals, and committing to participate in the research project, increasing exercise skills, rewarding those with the most accumulated days of exercise, and discussing successes and obstacles with encouragement from the research team.
4. Weeks *5-23* (Maintenance): The activities included allowing the EXP group to choose to exercise by themselves. Their exercise behaviors were adjusted to be consistent with their daily routine in order to maintain practice, prevent weight regain, and create positive reinforcement by being

supervised and monitored for exercise results through the online group, and the Line application was used to provide advice on exercise.

5. Week *24 (2* hours): Data of the EXP group and the CON group regarding the exercise behavior levels and BMI were collected. The EXP group also jointly evaluated the organized activities, indicated the benefits, problems and obstacles in doing the activities. Also, the rewards were given to the EXP group that made progress in losing weight and participated in every activity.

Control Group (*CON*)

The CON group did the exercises that they normally did in their daily life, such as aerobic dancing, walking, running, cycling, swimming, doing housework without going through the process of the exercise behavior change program. They were asked to exercise by using UBRU Fitness every Tuesday and Thursday for 24 weeks. They also received the same program as the EXP group at the end of the study.

Training program

The *3*-circuit training consisted of *9* exercises (Jumping jacks, Triceps dips, Sit-ups, Knee-hops, Russian twists, Lunges, Planks, Squats, and Jogging). Each exercise was performed for *40 - 50* seconds with *60* seconds of rest between sets, and *90* seconds of rest between circuits at an intensity of *64 - 76%* of maximum heart rate (Cerqueira et al., 2020). The Heart Zones (Rhythm+2.0; Scosche Industries P.R.C.) was used to control the exercise intensity. The exercise duration was 60 minutes/session, 3 times/week for 12 weeks (weeks 5-16) on Mondays, Wednesdays, and Fridays from 3:00 p.m. to 4:00 p.m. and 5:00 p.m. to 6:00 p.m. *(*figure 1*)*.

Figure 1. Outline of the circuit exercise program.

Measures

Cardiovascular measurements

An automatic blood pressure monitor (Omron HEM-7130, Japan) was used with the participant's left arm, outstretched and supported at heart level on a table, to measure blood pressure (BP) after about 15 minutes of rest. The assessment was performed twice, with a 2-minute recovery between measures. The average value of the two measures was used for statistical analyses. Blood pressure was calculated as SBP = systolic blood pressure *(*mm Hg*)*, DBP = diastolic blood pressure *(*mm Hg*)*, and resting heart rate (HR; beat/minute) was also measured.

Anthropometric and body composition measurement

The anthropometric measurement was performed. Weight (kg) and height (cm) were measured and calculated for BMI (kg*/*m2*)*. The body composition, including fat mass (%), fat-free mass (kg), muscle mass (kg), and visceral adipose tissue (L) was also measured using the Seca mBCA, Hamburg, Germany.

The participants were asked to take off their shoes and stand on the machine for approximately *5* minutes.

Behavior level assessment

The assessment was based on the stages of change model to control and promote exercise behavior. There were 5 multiple choice questions, asking about the level of health behavior. The respondents were asked to select only one answer. This assessment form was adapted from the weight loss behavior measurement scale of Prochaska & Velicer, *(*1997).

Exercise behavior questionnaire

It was created by the research team. The content was about exercise practices. The questionnaire was used to measure the practice in each activity using the rating scale, consisting of the questions about exercise behavior in terms of knowledge, attitude, and practice (IOC=0.80).

Quality of life questionnaire

The WHOQOL-BREF-THAI (Mahatnirunkul et al., 1997) was used. It was developed from the 2 concepts: objective and subjective, divided into *4* areas: physical subjective, psychological domain, social relationships and environment (IOC=0.93).

Data analysis

Statistical calculations were performed using SPSS 26 (IBM Corp., IBM SPSS Statistics for Windows, Version 26.0; Armonk, NY: IBM Corp). The data were reported as mean ± standard deviation (SD). The normality of the data was assessed using the Shapiro-Wilk test. The mean values of the variables before and after the *12*-weeks experiment, and after the *24*-week follow-up period were analyzed within the group using repeated measure. Once differences were found, pairwise comparisons were made using the Bonferroni method. The mean body composition, exercise behavior, and quality of life of the participants in the EXP group and the CON group were compared using the independent t-test, and the statistical significance level was set at *.05.*

Results

Table *1* shows the number and percentage of the personal information of the CON group and the EXP group in terms of age, marital status, congenital disease, and type of exercise. The mean and standard deviation of the personal and physiological data at the pre-experimental period of the CON group and the EXP group, namely age (*41.86* ± *3.76* vs. *43.40* ± *4.55* years), weight (*72.95* ± *8.63* vs. *69.87* ± *10.16* kg), height (*159.15* ± *5.08* vs. *159.00* ± *5.46* cm), BMI (*28.61* ± *3.29* vs. *27.65* ± *3.65* kg/ m2*)*, resting heart rate (*82.23* ± *12.43* vs. *81.50* ± *9.47* beats/min), resting systolic blood pressure (*121.31* ± *9.12* vs. *126.75* ± *11.49* mm Hg), and resting diastolic blood pressure (*81.91* ± *9.12* vs. *83.08* ± *6.84* mm Hg) were not significantly different at the *.05* level.

Table 1. Number and percentage of the personal information of the CON group and the EXP group.

Personal Information	CON (*n* = 14)		EXP (*n* = 15)	
	Number	Percentage	Number	Percentage
Age (y)				
30–39 years	6	42.86	5	33.33
40–49 years	4	28.57	7	46.67
50–59 years	4	28.57	3	20
Marital status				
Single	9	64.29	7	46.67
Married	5	35.71	8	53.33
Widowed	0	0	0	0
Divorced	0	0	0	0
Separated	0	0	0	0
Congenital disease				
Yes	0	0	0	0
No	14	100	15	100
Type of exercise				
1. Walking	7	50	4	26.68
2. Running	1	7.14	2	13.33
3. Aerobics	4	28.57	5	33.33

Table 1. Number and percentage of the personal information of the CON group and the EXP group.

Personal Information	CON (*n* = 14)		EXP (*n* = 15)	
	Number	Percentage	Number	Percentage
4. Cycling	0	0	2	13.33
5. Badminton	2	14.29	2	13.33
6. Swimming	0	0	0	0
7. Others	0	0	0	0

Table note: CON: control group; EXP: experimental group.

Table 2 presents the mean scores of exercise behavior in each period. It was found that the exercise behavior between the EXP group and the CON group at the pre-experimental period was not different. However, at the post-experiential period (Week 12) and the follow-up period (Week 24), it was significantly different at the .05 level (p=.004 and p=.005, respectively).

Regarding the body composition changes, when comparing between the pre-experimental period and the post-experiential period (Week 12), the EXP group's body weight, BMI, body fat percentage, muscle mass, and visceral fat mass were significantly different from those of the CON group at the *.05* level *(*p= .0*12*, p= .007, p= .009, p= .001 and p= .001, respectively, p<.05). Similarly, when comparing between the pre-experimental period and the follow-up period, the EXP group's body weight, BMI, and visceral fat mass changed significantly better than those of the CON group at the .05 level *(*p= .0*43*, p=.0*42*, and p= .0*33*, respectively, p<.05). In addition, when comparing between the post-experimental period (Week 12) and the follow-up period (Week 24), the EXP group's body weight, body mass index, body fat percentage, muscle mass, and visceral fat mass were significantly different from those of the CON group at the .05 level *(*p= .0*01*, p= .00*1*, p= .00*1*, p= .001 and p= .001, respectively, p<.05*)* (table 3).

Table 2. Comparison of the mean scores of exercise behavior between the CON group the EXP group at the pre-experimental period (Pre; week 0), the post- experimental period or Week 12 (Post; week 12), and the follow-up period or Week 24 (Follow; week 24).

Time	CG (*n* = 14)	EXP (*n* = 15)	t	p-value
Pre (week 0)	0.60 ± 0.00	0.60 ± 0.00	0.00	.500
Post (week 12)	0.66 ± 0.65	0.88 ± 1.12	0.04	.004*
Follow (week 24)	0.68 ± 0.94	0.92 ± 1.01	0.35	.005*

Table note: CON: control group; EXP: experimental group; Values are mean ± SD; t: t-value; p-value: statistical significance; *Significant p<.05 (CON vs. EXP).

Table 3. Mean, standard deviation, and percentage of change of body composition variables at the pre-experimental period, the post-experimental period (Week 12), and the follow-up period (Week 24) of the CON group and the EXP group.

Variables	Time	CG (*n* = 14)	EXP (*n* = 15)	t	p-value
		Body composition			
Weight (kg)	Pre (week 0)	70.86 ± 9.75	69.87 ± 10.16		
	Post (week 12)	71.86 ± 10.17	69.42 ± 9.96		
	Follow (week 24)	71.94 ± 9.85	69.49 ± 10.02		
	%Changes (Post vs. Pre)	0.71	-0.65	-2.408	.012‡
	%Changes (Follow vs. Pre)	1.52#(p = 0.008)	-0.54	1.817	.043 Ω
	%Changes (Follow vs. Post)	0.81	0.11	3.790	.001§
BMI (kg/m²)	Pre (week 0)	28.01 ± 3.43	27.65 ± 3.65		
	Post (week 12)	28.19 ± 3.63	27.44 ± 3.64		
	Follow (week 24)	28.42 ± 3.53	27.48 ± 3.68		
	%Changes (Post vs. Pre)	0.65	-0.73	-2.634	.007‡
	%Changes (Follow vs. Pre)	1.48#(p = 0.014)	-0.61	1.836	.042 Ω
	%Changes (Follow vs. Post)	0.83	0.12	3.834	.001§
Fat mass (%)	Pre (week 0)	39.35 ± 3.43	39.14 ± 3.71		
	Post (week 12)	39.25 ± 3.63	38.30 ± 3.81		
	Follow (week 24)	39.87 ± 3.39	38.82 ± 3.80		
	%Changes (Post vs. Pre)	-0.25	-2.16* (p = 0.002)	-2.539	.009‡
	%Changes (Follow vs. Pre)	1.57# (p = 0.029)	1.35# (p = 0.080)	0.437	.335
	%Changes (Follow vs. Post)	1.32† (p = 0.049)	-0.83† (p = 0.001)	4.051	.001§
Fat-Free mass (kg)	Pre (week 0)	42.31 ± 4.51	45.49 ± 5.61		
	Post (week 12)	42.73 ± 4.87	46.10 ± 5.75		
	Follow (week 24)	42.49 ± 4.34	45.58 ± 5.54		
	%Changes (Post vs. Pre)	0.98	1.35	0.557	.292
	%Changes (Follow vs. Pre)	0.42	0.21	0.670	.257
	%Changes (Follow vs. Post)	-0.56	-1.12	0.220	.414
Skeletal muscle mass (kg)	Pre (week 0)	19.31 ± 2.88	19.37 ± 3.32		
	Post (week 12)	19.25 ± 2.90	19.86 ± 3.32		
	Follow (week 24)	19.02 ± 2.94	19.79 ± 3.38		

	%Changes (Post vs. Pre)	-0.32	2.53* (p = 0.001)	4.710	.001‡
	%Changes (Follow vs. Pre)	-1.51# (p = 0.007)	2.20# (p = 0.004)	-1.426	.084
	%Changes (Follow vs. Post)	-1.20	-0.32	-5.222	.001§
Visceral adipose tissue (L)	Pre (week 0)	2.29 ± 0.51	2.05 ± 0.61		
	Post (week 12)	2.34 ± 0.56	1.91 ± 0.63		
	Follow (week 24)	2.35 ± 0.57	1.98 ± 0.62		
	%Changes (Post vs. Pre)	1.98	-7.12* (p = 0.002)	-3.490	.001‡
	%Changes (Follow vs. Pre)	2.08	-3.37# (p = 0.018)	-1.931	.033ɑ
	%Changes (Follow vs. Post)	0.78	4.03† (p = 0.017)	3.435	.001§

Table note: CON: control group; EXP: experimental group; BMI: body mass index; Values are mean ± SD; t: t-value; p-value: statistical significance; *Significant p<.05 (Post vs. Pre); #Significant p<.05 (Follow vs. Pre); †Significant p<.05 (Follow vs. Post); ‡Significant p<.05 CON vs. EXP (%Changes Post vs. Pre); ɑSignificant p<.05 CON vs. EXP (%Changes Follow vs. Pre); §Significant p<.05 CON vs. EXP (%Changes Follow vs. §Significant p<.05 CON vs. EXP (%Changes Follow vs. Post).

In particular, the mean scores of exercise behavior at the post-experimental period and the follow-up period between the CON group and the EXP group were significantly different at the .05 level. However, the mean scores of exercise behavior in terms of knowledge, attitude, and practice of the EXP group when compared between the pre-experimental period and the post-experimental period, between the pre-experimental period and the follow-up period, and between the post-experimental period and the follow-up period showed significant changes for the better at the .05 level (figure 2).

Similarly, the mean scores of quality of life of the EXP group and the CON group at the pre-experiment period were at a moderate level. However, after Week *12*, the overall quality of life of the EXP group was at a good level of (*98.73 ± 5.46)*, and that of the CON group was at a moderate level of (*89.64 ± 3.69)*. Nevertheless, at the post-experimental period between the EXP group and the CON group, there were differences in the mean scores of quality of life in terms of physical health, psychological health, and social relationships (p=.001, p=.003, and p=.001, respectively, p<.05). At the follow-up period (Week 24), the overall quality of life of the EXP group was at a good level (105.00 ± 5.24), and that of the CON group was at a moderate level *(*92.40 ± 3.67*)*. It was also found that at the follow-up period, the mean scores of quality of life were significantly different between the EXP group and the CON group at the *.05* level *(*p= .001, p=.00*7*, p=.012 and p=.001, respectively, p<.05*)*. Particularly, the EXP group showed improved changes in all aspects of quality of life when compared to the pre-experimental period, post-experimental period (Week 12), and the follow-up period (Week 24), while the CON group showed changes only in physical health and environment at the post-experimental period and the follow-up period (figure 3).

Figure 2. Changes in exercise behavior (knowledge, attitude, and practice) were observed in both the control group (A) and the experimental group (B). Values are present as mean ± SD; *Significant p<.05 (Post vs. Pre); #Significant p<.05 (Follow vs. Pre); †Significant p<.05 (Follow vs. Post).

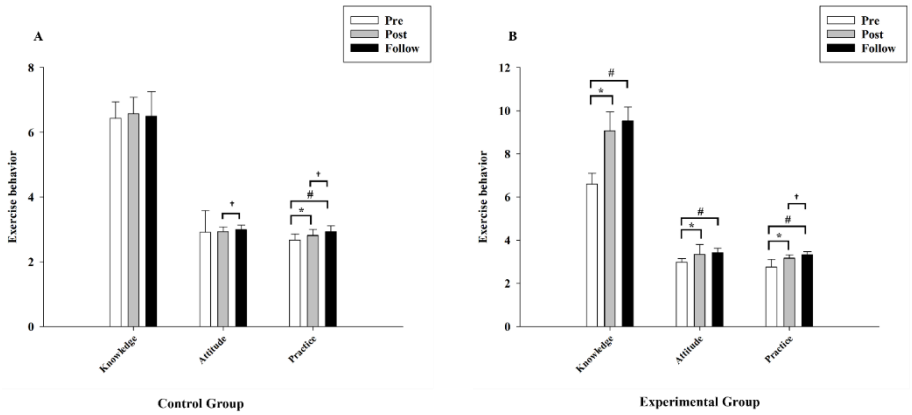
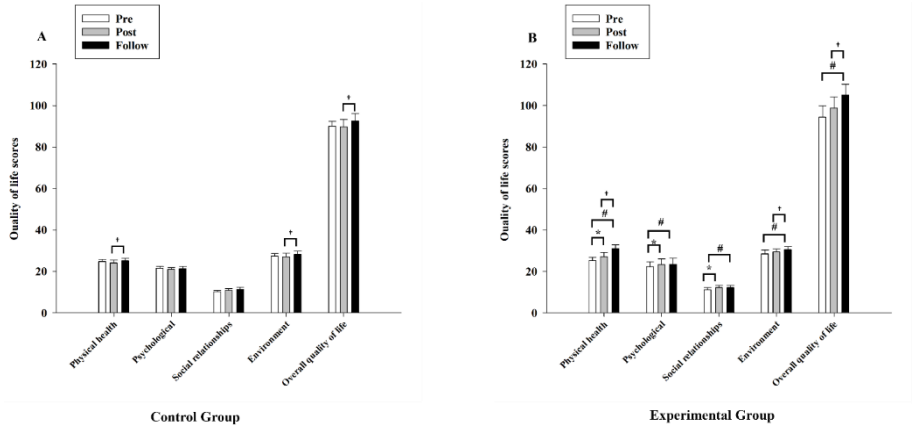


Figure 3. Changes in quality of life scores (physical health, psychological health, social relationships, environment, and overall quality of life) were observed in both the control group (A) and the experimental group (B). Values are present as mean ± SD; *Significant p<.05 (Post vs. Pre); #Significant p<.05 (Follow vs. Pre); †Significant p<.05 (Follow vs. Post).



Discussion

The application of the stages of change theory together with exercise enabled overweight working-age women to have proper health care behavior, improve their body composition, exercise behavior and quality of life because the activities were organized appropriately to the behavioral level using different strategies for behavior change. In this research, the behavioral process of overweight working-age women was evaluated to organize appropriate activities. Overweight working-age women were engaged in the preparation stage. The behavioral process was used in conjunction with higher knowledge and understanding as a strategy for behavior change. They were encouraged to have positive attitudes, decision-making power, and positive reinforcement from people around them. Social supporters were also trained to change weight loss behavior. In addition, to ensure continuity of the activity, exercise behavior was monitored to increase commitment to the set goals. As a result, the EXP group had appropriate exercise behavior and was able to improve body composition, exercise behavior, and quality of life. Moreover, the screening of the participants using a questionnaire that applied the stages of change theory allowed the EXP group to be ready to practice and have intention to take care of their health. This is consistent with the previous studies that applied the stages of change theory to develop health behavior modification programs, such as quitting smoking, losing weight, and quitting drinking alcohol. The success factors arose from behavior modification according to the stages of behavior change of each individual (Mason et al., 2008).

Body composition changes after *12* weeks of training indicated the effectiveness of the exercise program implemented among overweight working-age women. However, further studies are needed. The program was also effective in preventing chronic non-communicable diseases such as obesity, diabetes and cardiovascular disease (Thompson et al., 2013). Generally, overweight working-age women tend to have low muscle mass, which may be due to the lack of physical activity or resistance exercise, and care and attention to eating behavior as well as having low-mobility behavior. A study by Li et al. (2018) investigated the associations of muscle mass and strength and mortality. It was found that low muscle strength was associated with an increased risk of mortality and metabolic syndrome. On the contrary, people with normal or high muscle strength tended to have a reduced risk of premature mortality and metabolic syndrome. It is suggested that people who continuously develop their strength will have more physical activity behaviors than those with low muscle strength (Li et al., 2018). Thus, participation in the experimental program, requiring participants to exercise *3* times per week, is likely to reduce the risk of mortality as shown in the pervious study mentioned above. Furthermore, the risk of cardiovascular disease tends to be reduced by moderate-intensity circuit training (Torres et al., 2023). It can be concluded that moderate-intensity circuit training improves body composition, such as a decrease in fat and an increase in muscle mass (Ramos-Campo et al., 2021). In particular, the increase in muscle mass may be due to the use of bodyweight resistance training in the program, which causes more muscle

changes and development. This is line with the use of resistance circuit training that can improve muscular fitness (Klika & Jordan, 2013). Similarly, a study by Irene-Chrysovalanto et al. (*2021)* found that moderate-intensity circuit training could improve the quadriceps and hamstrings in overweight and obese individuals (Irene-Chrysovalanto et al., 2021).

Regarding changes in exercise behavior after training among working-age women, the study of Izquierdo et al. (*2021)* points out that from adults to older adults, there is a tendency of a decrease in physical activity, and the decrease will continue with increasing age. It is suggested that increasing physical activity or exercise can develop health behavior to be more active and maintain daily physical activity levels. It also tends to prevent non-communicable diseases in the future (Izquierdo et al., 2021). In this study, the EXP group had improved health behaviors, which may affect the tendency to maintain physical activity levels after the experiment ended and to continue health behaviors with appropriate physical activities. It also had a positive effect on body composition. It has also been found that the older the persons, the less physical activity they have. In terms of psychological health development or management, increasing physical activity or exercise, especially aerobic and resistance exercise, is another option for programs used to treat anxiety or post-traumatic stress disorder and various negative psychological tendencies. Exercise can reduce stress levels in individuals. In particular, moderate-intensity exercise can lead to better health behaviors, such as reduced intake of sugary and fatty foods (Carek et al., 2011; Smith & Merwin, 2021). In the long run, the circuit training has the potential to improve self-esteem in addition to its beneficial effects on physical fitness (Borbón-Castro et al., 2020).

As for the development of quality of life after the experiment, there was a better change that may be due to the change of physical activity and exercise behavior. This is to say, the awareness of the importance of exercise and the circuit exercise program combined with the stages of change theory can lead to the health behavior change in a developmental way according to health behavior change theories (Michaelsen & Esch, 2021). It can be explained that exercise has a positive effect on the development of physical fitness, making people perceive changes after exercise. Changes in a positive way are considered behavioral rewards according to the theory. The evaluation of quality of life after training may allow exercise behavior to promote and support this matter. It is also well recognized that food and nutrition affect quality of life. If people exercise or start taking care of their health, they will also take care of their eating behaviors. Or among people with inappropriate eating behaviors, exercise can help improve these behaviors (Mathisen et al., 2020). In the same way, a study by Aydin et al. (2021) investigated the effects of exercise on quality of life among people with cancer who performed aerobic and resistance exercise for 12 weeks, and found that after the experiment, exercise could improve quality of life in terms of physical fitness, functioning, emotion, and social functioning, and reduce fatigue, pain, and sleep disturbances. It was also found that exercise tended to reduce symptoms of depression (Aydin et al., 2021). In addition, water exercise interventions tended to improve emotional well-being, while yoga and Pilates tended to improve social and family well-being (Odynets et al., 2019). Additionally, aerobic exercise highly stimulating the sensory system tended to improve both physical and mental fitness (Reina-Gutiérrez et al., 2022). Also, the training developing strength, flexibility, and mobility of core and hip muscles could improve quality of life in terms of daily living, muscle endurance during muscle-using activities, or facilitate daily living (Kim & Yim, 2020). Previous studies have indicated that exercise programs or physical activities have been recommended to maintain or improve quality of life. Aerobic, resistance, movement and flexibility exercises have been recommended as the main exercises for improving quality of life. This present study suggests that the moderate-intensity circuit exercise program combined with the stages of change theory may be effective in improving the quality of life. Moreover, the exercise program may have a positive effect on the long-term quality of life of working-age women. It is likely to make the participants enjoy exercising and be able to change their exercise behavior in the long term (Lucini & Pagani, 2021).

Conclusions

Health behavior change among overweight working-age women through the application of the stages of change theory resulted in better exercise behavior. The exercise behavior change was developed from the practice stage to regular and continuous exercise. Therefore, overweight working-age women could

use the moderate-intensity circuit exercise program combined with the stages of change theory to induce behavior change, with the motivation, support and encouragement from the researchers, and learn through the program until it was implemented. The relapse to previous health behaviors was prevented by providing information to the participants, which resulted in improvements in body composition, exercise behavior, and quality of life.

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Conflict of interest

The authors declare that they have no conflict of interest.

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