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Research Article

Promoting Exercise Cognition and Behavior in Young Females: An Intervention Study of Different Exercise Types

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Abstract

The purpose of this study is to understand young females, through exercise interven-tion to improve young females' exercise cognition and behavior. A total number of 60 healthy young females were randomly recruited in this study and were randomly assigned to experi-mental group A (EGa: mean age 22.7±1.27 years), experimental group B (EGb: mean age 22.4±1.42 years), and control group (CG: mean age 22.5±1.33 years), each group was divided into 20 people, and the experimental time was 12 weeks. The EGa performed aerobic exercise intervention, while EGb performed anaerobic exercise intervention, and the CG carried out their daily routines as usual. The intervention study experiment lasted for a total of 12 weeks by assessing their exercise cognition and behavior scale in completing the experiment. After the intervention study in ex-perimental groups, it was found that these young females' exercise cognition and exercise be-havior outcomes were significantly improved, while the exercise barriers were significantly re-duced. Regression analysis of each factor showed that after aerobic exercise or anaerobic exercise intervention, the exercise cognition and exercise barriers in experimental groups A and B had a high degree of explanatory power for exercise behavior outcomes (R2=76.5%, R2= 58.2%). This study can be concluded that promoting exercise cognition of young females, using aerobic or anaerobic exercises, and eliminating psychological exercise barriers can lead to strong exercise behavior outcomes.

Keywords: Aerobic Exercise; Anaerobic Exercise; Exercise Cognition; Exercise Barriers; Exercise Behavior

Introduction

Despite the health benefits of exercise [1-3], young people and adults have re-mained inactive over the past decade [4]. A new global physical activity initiative launched by the World Health Organization in 2018 for a healthier world found that 60% of females fail to achieve 30 minutes of physical activity a day [5], especially the majority of young females who were physically inactive or inactive [6-8]. The U.S. Na-tional Health and Nutrition Examination report noted a general decline in exercise be-havior among young females after high school graduation, not meeting U.S. physical activity guidelines [9]. This was the main reason why this study focused on young fe-males.

The so-called exercise cognition is the collective term for exercise perception, at-tention, working memory, recognition, and executive function [10]. Cognitive reap-praisal is performed when the situation is threatening, and negative behaviors may occur when the inner evaluation is negative thoughts [11]. However, positive exercise cognition refers to setting exercise goals, formulating exercise plans, and setting the intensity and duration of each exercise. Therefore, enhancing positive exercise cogni-tion helps to establish exercise behavior [12]. On the contrary, if a female uses a nega-tive thought in real life or psychology to influence others individuals not to exercise, it could be a common exercise barrier [13]. The investigation by Joseph et al. found the reasons for young females' lack of exercise, such as physical fatigue caused by work, bad weather and do not want to go out, too expensive gyms, little time to exercise with children, lack of motivation to exercise alone, and embarrassing to exercise in front of the opposite sex [14]. Therefore, psychological thoughts often affect individual exercise cognition, and the more negative thoughts, the deeper the exercise barriers [15]. In ad-dition, many research studies on exercise cognition were mainly on older adults and children [16-22], little research has been done on young females, and more extensive research was needed on the benefits of exercise cognition on exercise behavior. While exercise was well for both physical and mind, most young females didn't exercise very often, and data showed that negative cognitive thoughts were the main reason for not exercising [23].

The types of general public exercise can be divided into aerobic exercise and an-aerobic exercise. In contrast, aerobic exercise is a low-to-medium-intensity or inter-mittent exercise that can be carried out for a long time. The oxygen has enough time to enter the tissue cells so that the body's carbohydrates, fats, and proteins are fully oxi-dized to generate the energy required for this aerobic exercise [24-26]. Aerobic exercise examples include jogging, climbing stairs, swimming, and others. Anaerobic exercise is a moderate to high-intensity, intense short-term exercise. In anaerobic exercise, the inhaled oxygen has limited time to burn before the exercise ends [27]. Anaerobic exer-cises include sprinting, weightlifting, squats, and resistance training. These two exer-cise types produce different effects [28]. Aerobic exercise has enough oxygen to partic-ipate in metabolism, consumes carbohydrates and fat, and consumes a small amount of protein, and its effect can reduce overall body fat [29]. Due to the lack of oxygen in an-aerobic exercise, the human body metabolizes only a single carbohydrate and, at the same time, produces a lot of metabolic wastes. These wastes cannot be quickly taken away by blood circulation, and it is easy to cause the accumulation of lactic acid. The effect strengthens the muscles, builds the body muscles group, depicts body curves, and shapes the body [30].

Based on the above literature, this study proposed an intervention to improve young females' exercise cognition and behavior. Extending the above purpose attempts to address the following two questions:

a) What was the difference between young fe-males participating in the aerobic and anaerobic exercise on exercise cognition and be-havior?

b) What was the effect of an exercise intervention on exercise cognition and behavior in young females? Based on the research question, this research hypothesis was proposed as hypothesis one: Young females participating in the aerobic and an-aerobic exercise had significant differences in exercise cognition and behavior, and hypothesis two: Young females had an effect on exercise cognition and behavior after exercise intervention.

Materials and Methods

Research Participants

This study was from the Physical Fitness Center Taiwan College of Performing Arts (experimental site). The recruitment information was forwarded by the Physical Fitness Center of the Taiwan College of Performing Arts to the information announced by the student union of the neighboring university (recruitment conditions: no exercise on weekdays and holidays, only female college students with normal daily routines. Recruitment Offer: 1 free gym access). Open recruitment of 60 healthy young female college students in Taipei City, with a sample size consistent with sample estimates for sports science research [31]. All participants signed informed consent and health dec-larations at their own discretion (excluding those who were unable to participate due to environmental, identity or social and economic conditions). The recruited partici-pants first fill in their personal background information, including age (years), weight (kg), and height (cm). Participants were randomly assigned to three groups of 20 par-ticipants: experimental group A (mean age 22.7±1.27 years old), experimental group B (mean age 22.4±1.42 years old), and control group (mean age 22.5±1.33 years old). There was no significant difference in the age, height, and weight of the three groups after One-way ANOVA analysis, indicating that the results of the random allocation of par-ticipants were homogeneous, as shown in Table 1. This study was approved by the Jen-Ai Medical Foundation Dali Jen-Ai Hospital: Human Body Research Ethics Com-mittee, approval number 110-96.

Table 1: Cross-sectional study pre-test on participants' characteristics.

Variables	EGa M ± SD	EGb M ± SD	CG M ± SD	*F* Value	*p*-Value
Age (years)	22.7 ± 1.27	22.4 ± 1.42	22.5 ± 1.33	0.91	0.105
Height (cm)	161.9 ± 5.7	161.7 ± 5.9	162.1 ± 6.2	0.76	0.143
Weight (kg)	53.9 ± 5.9	53.7± 6.1	54.1 ± 5.5	0.84	0.121

[1]Means ± standard deviations presented as M ± SD; experimental group A (EGa); experimental group B (EGb); n=20 in each group.

Research structure

The homogeneity of the three groups was consistent with random assignment [32]. Experimental groups A and B performed exercise intervention three times per week for 12 weeks, the weekly frequency of the experiment, and the total number of weeks, consistent with many studies [33-37]. This experiment was carried out in the Taiwan College of Performing Arts gymnasium. The experimental group A and experimental group B performed aerobic and anaerobic exercise interventions, respectively, while the control group performed daily regular life routines. The experimental group A and experimental group B performed moderate to vigorous exercise each time, in line with the intensity, frequency, duration, and group performance of the exercise [38-40].

Research materials

Aerobic exercise intervention

The experimental group A performed 12 weeks of maximal capacity training using interval training (moderate to high intensity) and long-distance jogging (moderate in-tensity) [41]. This was to strengthen the heart and lungs through cardiorespiratory endurance training, which makes the muscles more efficient at using oxygen and in-creases cardiac output [42], as shown in Table 2.

Table 2: Aerobic training program.

Week	Type	Intensity	Training style
Monday	Interval training (flywheel)	MHR: 70-90%	1. Warm-up: Ride easily for 5 min, and maintain the speed at 60 to 70 rpm. 2. Increase the resistance: After increasing the resistance, ride for 5 min and maintain the speed at 70-80 rpm. 3. Standing position pumping: After increasing the resistance, perform "standing pumping" for 1 min, ignoring the speed for the time being. 4. Lower the resistance: lower the resistance, ride for another 10 min, and keep the speed at 80 rpm. 5. Easing: After lowering the resistance again, ignore the speed and pedal easily for 2 min.
Wednesday	Interval training (Treadmill exercise)	MHR: 60-90%	1. Walk (6 km/hr for 3 min) 2. Fast walking (7 km/hr, lasts 5 min) 3. Jogging (speed: 8 km/hr for 5 min) 4. Run fast (speed: 10 km/hr, lasts 2 min) 1→2→3→4, which is a cycle, a total of 2 cycles.
Friday	Isokinetic training (Treadmill exercise)	MHR: 60-80%	Jogging (speed: 8 km/hr for 30 min)
[1]MHR: maximum heart rate			

Anaerobic exercise intervention

Table 3: Resistance training program for the anaerobic exercise group.

Course	No. of Reps/Sets (*total=3 sets*) *(70%)*	*(80%)*	*(100)*	Training focus
Warm-up	-			10 min of aerobic exercise.
Squat (or leg press)	10/1	6/2	1-3/3	Squat lift exercise by weightlifting using the lower body, leg power, and strength.
Bench press (barbells, dumbbells, Smith machine)	10/1	6/2	1-3/3	Focus on building chest muscles, arm triceps, and front deltoid shoulder muscles.
Deadlift	10/1	6/2	6/2	
Crunch	10/1	6/2	1-3/3	Upper body remains on the mat as the abs contract by drawing the legs toward the chest
Seated cable row	10/1	6/2	1-3/3	Focus on back muscles and forearms.

Triceps pushdown	10/1	6/2	1-3/3	Focus on triceps development.
Lat pulldown	10/1	6/2	1-3/3	Focus on the back muscles.
Overhead press	10/1	6/2	1-3/3	Done by sitting or standing position, with dumbbells held horizontally at the shoulders or rotated in a hammer grip.
Biceps curl	10/1	6/2	1-3/3	Arms curl variations using dumbbells, kettlebells, barbells, or cable machines.
Cool-down	-			Muscle relaxation by foam rollers stretching or static stretching.
[1]First set (round) strength of 70% RM; Second set (round) strength of 80% RM; and Third set (round) maximum personal strength of 100% RM.				

The experimental group B performed a Resistance Training Program (RTP) and a revised RTP suitable for the participants [43], as shown in Table 3. Prior to starting the program, the maximum muscle strength test of each participant in the experimental group will be tested. The maximum muscle strength is categorized into 70%, 80%, and 100% of the maximum repetitions (RM). Participants were given 2 min rest between each set (round) and a 30-second transition time for each group [44]. The intensity of weight training was shown in Metabolic Equivalent (MET), defined as 3.5 ml of oxygen per minute per kilogram of body weight, roughly equivalent to a person sitting in a calm state without any activity. Oxygen per minute intake during an activity of 5 METs means that the oxygen intake during exercise was 5 times more than that of the rest state [45]. Thus, in this study, a moderate to high intensity was performed at around 3.0-5.9 METs, which resulted in participants feeling a little exhausted, sweating, and breathing faster than usual.

Testing method: Exercise cognition and behavior questionnaire

The questionnaire of this research was based on the "Cognitive Behavioral Physi-cal Activity Questionnaire" compiled by Schembre, et al. [46]. Since this questionnaire mainly investigates college students' social cognition of physical activity, in order to meet the theme of this research, according to the questionnaire revision of each item. The revision was completed through expert validity by sports professors to match the "Exercise Cognition and Behavior Questionnaire" of young females. This questionnaire uses the Litke five-point scale. Then, 100 female college students were sampled by the Taiwan College of Performing Arts for the pre-test. Finally, according to the data ob-tained in the pre-test, item analysis, factor analysis, reliability, and validity analysis were carried out.

Project analysis

In this study, the item analysis of the "Exercise Cognition and Behavior Question-naire" was carried out using the correlation coefficient and decision value (CR) be-tween each item and the total score. After the item analysis, the items were all greater than 3.5, and the correlation with the total score is between 0.8 and 0.9, showing a high correlation. , indicating that the questions in this questionnaire were retained and did not need to be deleted.

Factor analysis

KMO and Bartlett's sphericity test was done and the result obtained for KMO=0.936, with Bartlett's sphericity test of $\chi2=344.28$ reaching a significant level. It could be seen that the correlation matrix representing the population has a common factor, so it was suitable for factor analysis. The principal component analysis method extracted factors with eigenvalues greater than 1. The maximum variation method of the orthogonal axis was used to screen out the items with factor loadings below 0.40. All items had factor loadings higher than 0.40. A total of 19 questions were obtained as formal questionnaires used. The total cumulative explained variance was 73.19%, indi-cating that the scale has good validity. Three factors were extracted from this ques-tionnaire, namely exercise cognition (questions 1-7), exercise barriers (questions 8-12), and exercise behavioral outcomes (questions 13-19), as shown in Table 4.

Table 4: Exercise cognition and behavior questionnaire in young females.

No.	Factor	Item
1	Exercise cognition (EC)	I made exercise a part of my life.
2		I exercise at certain times of the week to maintain regularity.
3		I set goals for myself to stay physically active.
4		I pledge to keep exercising.
5		I made a plan to make sure I got enough exercise.
6		I will set the intensity and duration of each exercise.
7		I know that exercise improves memory.

8	Exercise barriers (EB)	I do not have time to exercise.
9		The weather is bad, and I do not want to go out.
10		There is no motivation to exercise alone.
11		I am tired and do not want to exercise anymore.
12		Exercising in front of the opposite sex is embarrassing.
13	Behavioral outcomes (BO)	I find that exercise gives me a lot of energy.
14		I realize that my body feels better after exercising.
15		Exercise gives me a strong sense of accomplishment.
16		Exercise improves my mood.
17		I think exercise is an effective way to relieve stress.
18		I find that exercise makes my mind clearer.
19		I ask myself to exercise at moderate intensity and sweat a lot.

Reliability analysis

A Cronbach's alpha internal consistency test was used to test the reliability. The higher the coefficient, the better the reliability. The value between 0.73 and 0.94 are high reliability, which shows that after the test, a Cronbach's α=0.91 for exercise cogni-tion, Cronbach's α=0.94 for exercise barriers, Cronbach's α=0.92 for be-havioral out-comes, and Cronbach's α=0.93 for the total scale were obtained. Therefore, this scale had good reliability.

Control variable

Healthy young females were recruited as participants. There are unconsidered factors or irrelevant variables in the control group (three groups were pre-tested as homogeneity). In addition, due to the open recruitment of female college students who do not exer-cise on weekdays, the participation of all recruited participants was also within the control range. In addition, exercise environment, exercise time, peer rela-tionship in group, etc. were all control vari-ables in this study. Since the results of mul-tiple regression analysis can explain which independent variable is the most important, the resulting equation can also explain the unique effect of each in-dependent variable on the dependent variable. The influence and effect of independent variables con-trolled before the experiment on the dependent variables at regression explain the ex-planatory power of independent variables to the dependent variables, which can be increased., such as participant motivation, body size, and ex-ercise experience. In addi-tion, the experimental site had dietary propaganda materials. After each experiment with experimental groups A and B, the coach would give oral propaganda for a short 3 minutes, which was the control variable of diet.

Statistical analysis

The statistical analysis includes mean and standard deviation, homogeneity test, multiple comparisons of One-way ANOVA, and LSD post-hoc test (applicable to many-to-one comparisons with few tests and trim significance levels). An overall sig-nificance level is set to $p < 0.05$. Pearson product-moment correlation analysis and mul-tiple regression analysis were used to understand the explan-atory power of exercise cognition and exercise barriers of young females for exercise behavior outcomes. Sta-tistical analysis was performed using SPSS 20.0 software (IBM®, Armonk, NY, USA).

Results

At the end of the 12-week exercise program intervention, a questionnaire-based assessment was conducted to determine whether young females' exercise cognition and behavior were sig-nificantly improved. The following is the analysis of the results of this study.

Analysis of each item of the participants' questionnaire

Questions 8-12 of this scale were reverse questions. SPSS anal-ysis was conducted, and data coding was done; answer 1 was con-verted to 5, 2 was converted to 4, and so on. The average score of these answers was counted. The analysis of each item of exer-cise cognition and behavior of the participants is shown in Table 5. The average values of EGa and EGb in each exercise cognition item and behavioral outcomes agreed with the option, while CG disagreed with the option. The average values of EGa and EGb in each item of exercise barriers were in disagreement, while CG was in agreement. The above showed that after 12 weeks of exercise intervention for EGa and EGb, young fe-males significantly improved exercise cog-nition, barriers, and behavioral outcomes. It was also shown that the CG participants did not exercise often, did not have time, lacked the motivation to exercise, and did not exercise in their spare time.

Statistical analysis of various factors of participants

The statistical analysis of each factor of the participants is shown in Table 6 and Figure 1. It was found that aerobic exercise (EGa) and anaerobic exercise (EGb) after 12 weeks of exercise in-tervention, exercise cognition, exercise barriers, and behavioral outcome were all highly agreed, while CG has a low/slight agree-ment. Among them, the CG always has no time, lacks the motivation to exercise, and considers it a barrier. The experimental results af-ter the exercise intervention, the participants had a high degree of exercise cognition and behavioral outcome and believed that there were no barriers to exercise. In addition, the post-hoc comparison of EGa and EGb found that EGa is greater than EGb in all three factors, indicating that the cognition and behavior of young females participating in the aerobic exercise were better than those of young females participating in anaerobic exercise. These confirmed the acceptance of the hy-pothesis (H1): There was a difference between the participation of young females in aerobic and anaerobic exercise.

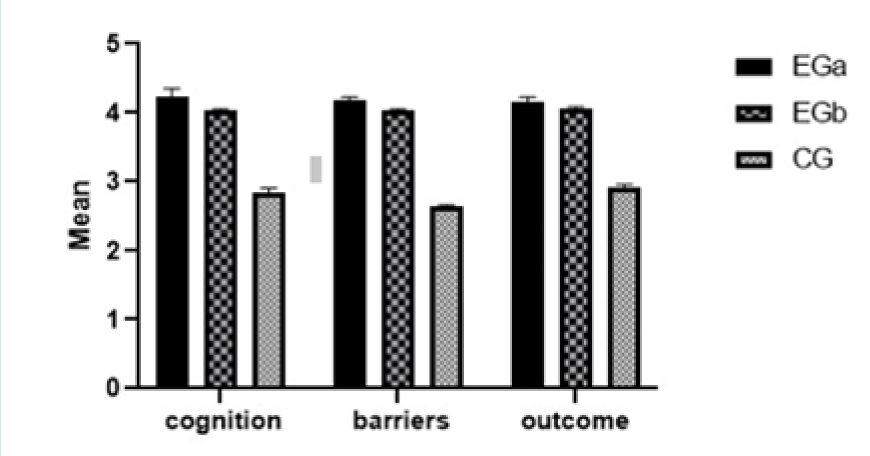

Figure 1: Mean comparison of each factor in the three groups.

Table 5: Analysis of each item of the participants' questionnaire.

Factor	Item	EGa (n=20) M ± SD	EGb (n=20) M ± SD	CG (n=25) M ± SD	F-value (p-value)
EC	I made exercise a part of my life.	4.41 ± 0.07	4.03 ± 0.06	2.79 ± 0.13	9.13* (0.0009)
	I exercise at certain times of the week to maintain regularity.	4.32 ± 0.03	4.05 ± 0.05	2.86 ± 0.07	8.25* (0.001)
	I set goals for myself to stay physically active.	4.17 ± 0.08	4.06 ± 0.07	2.76 ± 0.09	7.87* (0.003)
	I pledge to keep exercising.	4.21 ± 0.09	4.04 ± 0.11	2.83 ± 0.08	8.42* (0.001)
	I made a plan to make sure I got enough exercise.	4.16 ± 0.02	4.01 ± 0.12	2.81 ± 0.09	7.72* (0.005)
	I will set the intensity and duration of each exercise.	4.08 ± 0.09	4.02 ± 0.12	2.95 ± 0.13	7.84* (0.004)
	I know that exercise improves memory.	4.33 ± 0.05	4.00 ± 0.12	2.88 ± 0.05	9.73* (0.0005)
EB	I do not have time to exercise.	4.21 ± 0.07	4.05 ± 0.12	2.61 ± 0.07	9.39* (0.0008)
	The weather is bad, and I do not want to go out.	4.23 ± 0.05	4.01 ± 0.12	2.59 ± 0.08	9.75* (0.0005)
	There is no motivation to exercise alone.	4.14 ± 0.12	4.07 ± 0.12	2.65 ± 0.02	8.62* (0.001)
	I am tired and do not want to exercise anymore.	4.18 ± 0.06	4.02 ± 0.12	2.67 ± 0.03	8.47* (0.001)
	Exercising in front of the opposite sex is embarrassing.	4.20 ± 0.09	4.06 ± 0.12	2.63 ± 0.06	9.21* (0.0009)
BO	I find that exercise gives me a lot of energy.	4.23 ± 0.05	4.09 ± 0.12	2.89 ± 0.10	9.66* (0.0006)
	I realize that my body feels better after exercising.	4.18 ± 0.08	4.06 ± 0.12	2.95 ± 0.03	8.68* (0.001)
	Exercise gives me a strong sense of accomplishment.	4.13 ± 0.04	4.08 ± 0.12	2.85 ± 0.07	7.52* (0.006)
	Exercise improves my mood.	4.19 ± 0.06	4.04 ± 0.12	2.86 ± 0.11	8.25* (0.001)
	I think exercise is an effective way to relieve stress.	4.13 ± 0.07	4.05 ± 0.12	2.91 ± 0.08	7.81* (0.003)
	I find that exercise makes my mind clearer.	4.04 ± 0.13	4.01 ± 0.12	2.98 ± 0.04	7.57* (0.006)
	I ask myself to exercise at moderate intensity and sweat a lot.	4.22 ± 0.08	4.09 ± 0.12	2.93 ± 0.05	9.46* (0.0008)

*$p<0.05$; [1]Data presented as mean ± standard deviation (M ± SD); EGa: experimental group A; EGb: experimental group B; CG: control group; EC: exercise cognition; EB: exercise barriers; BO: behavioral outcome.

Table 6: Questionnaire analysis of participants.

Factor	EGa (n=20) M ± SD	EGb (n=20) M ± SD	CG (n=20) M ± SD	F-value (p-value)	Post-hoc LSD
Exercise cognition	4.24 ± 0.12	4.03 ± 0.03	2.84 ± 0.06	9.59* (0.002)	EGa >EGb >CG
Exercise barriers	4.19 ± 0.04	4.04 ± 0.02	2.63 ± 0.03	13.65* (0.001)	EGa >EGb >CG
Behavioral outcome	4.16 ± 0.07	4.06 ± 0.03	2.91 ± 0.05	10.72* (0.001)	EGa >EGb >CG

**p* < 0.05; [1]Data presented as mean ± standard deviation (M ± SD); EGa: experimental group A; EGb: experimental group B; CG: control group; LSD: Post-hoc comparisons, for Fisher's least significant difference.

Pearson product-moment correlation analysis of factors in the questionnaires of three groups

The participants' exercise cognition was correlated with various factors of the be-havioral questionnaire. Since each group was on an equidistant scale, Pearson prod-uct-moment correlation analysis was used, as shown in Table 7. The correlation coeffi-cient describes the degree of correlation between each factor within each group and the degree of correlation between each factor. The results showed a significantly high correlation (p < 0.05) among the factors in the EGa, and the correlation coefficient was between 0.81 and 0.85. There was a significantly high correlation (p < 0.05) among all factors within the EGb, and the correlation coefficient was between 0.72 and 0.75. There was a significantly low correlation (p < 0.05) among the factors of CG within the group, and the correlation coefficient was between 0.22 and 0.27. The above showed a high correlation between exercise cognition, exercise barriers, and behavioral outcome of EGa and EGb. The correlation coefficients of exercise cognition and behavioral out-come are 0.85 (p < 0.05) and 0.75 (p < 0.05), respectively, indicating a high degree of ex-ercise cognition. The aerobic exercise group (EGa) and the overall correlation coeffi-cients were higher than the anaerobic exercise group (EGb). Capable of producing a high degree of behavioral exercise results.

Table 7: Pearson product-moment correlation analysis of factors in the questionnaires.

		EGa			EGb			CG		
		EC	EB	BO	EC	EB	BO	EC	EB	BO
EGa	EC	1								
	EB	0.83*	1							
	BO	0.85*	0.81*	1						
EGb	EC	0.75*	0.74*	0.77*	1					
	EB	0.73*	0.75*	0.78*	0.73*	1				
	BO	0.76*	0.77*	0.79*	0.75*	0.72*	1			
CG	EC	0.17*	0.22*	0.21*	0.15*	0.17*	0.18*	1		
	EB	0.21*	0.18*	0.19*	0.19*	0.14*	0.17*	0.22*	1	
	BO	0.23*	0.20*	0.24*	0.13*	0.18*	0.16*	0.23*	0.27*	1

* p<0.05; [1] EGa: experimental group A; EGb: experimental group B; CG: control group; EC: exercise cognition; EB: exercise barriers; BO: behavioral outcome.

In addition, each factor between EGa and EGb reached a significantly high corre-lation (p < 0.05), and the correlation coefficient was between 0.73 and 0.80. All factors between EGa and CG reached a significantly low correlation (p < 0.05), and the correla-tion coefficient was between 0.24 and 0.17. All factors between EGb and CG were sig-nificantly low correlated (p < 0.05), with correlation coefficients between 0.19 and 0.13. The above shows a high correlation between EGa and EGb in exercise cognition, exer-cise barriers, and behavioral outcomes, whereas there was a low correlation between EGa and EGb and CG. Correlation data from the three groups after 12 weeks of daily life, compared with EGa and EGb, shows that CG lacks exercise cognition, with several reasons for exercise barriers and poor exercise behavior. EGa and EGb improved par-ticipants' exercise cognition due to the 12-week exercise intervention, which also re-sulted in good exercise behavioral outcomes.

The explanatory power of exercise cognition and exercise barriers on behavioral outcomes

The explanatory power of two independent variables, such as exercise barriers (EB) and behavior outcome (BO), was analyzed by multiple regression analysis. The statis-tical significance of this regression model was first tested. After Pearson prod-uct-moment correlation analysis, it was found that the aerobic exercise group (EGa) and the anaerobic exercise group (EGb) were highly correlated with various exercise cognition and behavior factors. The F-test results of the dependent variable and the two independent variables were significantly different, F=217.364* (p < 0.01) for EGa, and F=185.711* (p < 0.01) for EGb. Finally, multiple regression analysis was used to an-alyze the explanatory power of the forced entry method (two independent variables were considered in the regression model) and the explanatory power of the exercise behavior outcome of the dependent variables.

The explanatory power of EC and EB of EGa to BO reached a significant level (p < 0.01), and the explained variance was R2 = 76.5%. Among the two independent varia-bles, the estimated value of EC had the most significant impact on BO in young fe-males (β=0.584, p < 0.01), followed by EB (β=0.469, p < 0.01). Both independent variables β were positive, indicating that the independent variables positively affected BO in young females. The regression equation for the exercise behavior outcome of EGa: BO = 0.584 EC + 0.469 EB, as shown in Table 8.

Table 8: Multiple regression analysis of EGa.

Variable	β	R	R^2	Adjusted R^2	*p*-value
EC	0.584*	0.875	0.766	0.765	0.001
EB	0.469*				0.002
*p<0.01; [1]Independent variables: exercise cognition (EC), exercise barriers (EB). Dependent: behavior outcome (BO).					

Furthermore, the explanatory power of EC and EB of EGb on BO reached a signifi-cant level (p < 0.01), and the explained variance was R2 = 58.2%. Among the two inde-pendent variables, the estimated value of EC had the most significant impact on BO in young females (β=0.417, p < 0.01), followed by EB (β=0.355, p < 0.01). Both independent variables β were positive, indicating that the independent variables positively affected BO in young females. The regression equation for the exercise behavior outcome of EGb: BO = 0.417 EC + 0.355 EB, as shown in Table 9. These confirmed the acceptance hypothesis (H2): Exercise intervention affects exercise cognition and behavior in young females.

Table 9: Multiple linear regression analysis of EGb.

Variable	β	R	R^2	Adjusted R^2	p-value
EC	0.417*	0.763	0.582	0.581	0.003
EB	0.355*				0.007
*p<0.01; [1]Independent variables: exercise cognition (EC); exercise barriers (EB); Dependent: behavior outcome (BO).					

Discussion

Aerobic and anaerobic exercise with different energy metabolism interventions in this study helped understand the exercise cognition and exercise behavior of young females aged 18-24, which is the main objective discussion of this paper.

Firstly, the experiment was designed in three groups, experiment groups of aer-obic and anaerobic exercise groups compared with the control group to evaluate the relationship between exercise cognition and behavior through exercise intervention. In this study, the aerobic exercise group used at least 25 minutes of mod-er-ate-to-high-intensity aerobic exercise 3 days a week, and the anaerobic exercise group used anaerobic exercise three days a week, which shows consistent views with the Physical Activity Guidelines for Americans [47]. After a 12-week exercise intervention, three days a week, the exercise cognition and behavior questionnaire was administered post-hoc and showed significant benefit. The EC, EB, and BO of the experimental group A and B were positively and highly correlated, and EC and EB had the effect of predicting BO, especially EC. The results of this study were consistent with the previ-ous literature [48-50].

In addition, the study found that the correlation coefficient of each factor in the aerobic exercise group was better than that in the anaerobic exercise group. A plausible explanation for this result is that young females value body image, and perceived aerobic exercise was significantly associated with changes in obesity and body image [51]. Another study confirmed that young females engaged in aerobic exercise more than twice as much as anaerobic exercisers [52], because they knew aer-obic exercise could achieve weight loss [53]. In recent years, literature has found that studies put forward the idea that females' participation in anaerobic exercises is healthier than other types of exercises. However, studies similar to this point of view were mainly aimed at postmenopausal females, which were related to osteoporosis and rapid decline in BMD. At this time, anaerobic exercise could increase lean body mass and confirmed that the quality of life of postmenopausal females with osteopo-ro-sis improved [54-56]. The main difference from the above literature was that females have distinct physiological differences at different ages. Thus, this study focuses on young females as young females at this young age focus on body image and use aero-bic exercise to help reduce fat [57]. This study showed that the aerobic exercise group was superior to the anaerobic exercise group. However, it seemed that both types of exercise have the same positive effect on exercise cognition in young females [58]. In addition, based on the above results, it is worth noting that the Haase study found no significant differences in the health benefits of moderate to vigorous exercise, whether it was spread out during the week or concentrated on holiday exercise [59]. Tsirtsakis found that regular weekday exercisers were more effective at improving cognitive performance than those who exercised only on holidays [60].

In this study, experimental group A and B had a higher average score in the ques-tionnaires for exercise barriers (questions 8-12 were reverse questions, which were an-alyzed by SPSS through data coding, and then the average score of each question was counted), showing that these two groups psychological perception of exercise barriers was low after exercise intervention, consistent with previous literature [61-64]. When we evaluated participants with exercise intervention compared to control group, exer-cise barriers as a mediator of exercise cognition and behavior. All participants had a linear relationship between exercise cognition, exercise barriers, and behavior out-comes, showing that the higher the exercise cognition and the lower the exercise bar-riers in young females, the easier way to practice exercise behavior. The control group participants tended to disagree on exercise barriers and formed low-level exercise be-haviors. It was found that the exercise intervention and exercise cognition of young females significantly affected the exercise behavior changes through multiple regres-sion analysis. We adopted multiple regression analysis and found that the intervention of exercise intervention, the exercise cognition of young females significantly affected the changes of exercise behavior. Similarly, previous research has shown that many young females have cognitive confusion about resistance training. They believed that resistance training would make muscles thicker. This was a wrong perception because females' bodies were born with a lack of male hormones, making it difficult for them to grow thicker muscles [65].

We also found that exercise cognition and exercise barriers were the main causes of increased exercise behavior. Interestingly, exercise cognition in this questionnaire was positively correlated with exercise barriers after statistical transformation, showed high exercise cognition and low exercise barriers, the more likely to produce exercise behavioral outcomes, the results are similar to the previous literature [66,67]. This study found that exercise intervention can help improve exercise cognition, and the reason was also confirmed by many studies that exercise can increased blood flow to the brain and help improved people's cognitive ability [3,10,68,69]. However, was there a difference in the cognitive effects of exercise between aerobic and anaerobic exercise in this study? In fact, there was no specific evidence to show the difference in the cog-nitive effects of the two kinds of exercise, but long-term regular exercise and acute aerobic exercise (one-time aerobic exercise), could improve brain cognition in different age groups [70]. In addition, some studies have confirmed that exercise intensity and cognitive performance showed an "inverted U-shaped" curve [71], which means that no exercise or low intensity (40% RM), high intensity (100% RM) had a significant ef-fect on cognitive performance. The positive effects were not significant, but moderate to high intensity (70% RM) significantly improved cognitive performance [72]. In this study, moderate-to-high-intensity exercise intervention was used to virtually improve exercise cognitive ability and help reduce exercise psychological barriers. This result was an important discovery and novelty of this study.

Well-known general positive effects of exercise include enhancing overall physical fitness and reducing obesity [73]. In addition, the positive effects of exercise on cogni-tive function have been described [74]. It was worth noting that EC, EB, and BO were significantly correlated after exercise intervention in the experimental group. Although the study showed that EC and EB have a causal relationship to BO, the cross-sectional design does not wholly and directly infer the causal relationship. In this regard, Giles et al. found that assessment of exercise cognition could reduce perceived exertion dur-ing endurance exercise [75]. Therefore, cognitive exercise assessment might increase the duration of an individual's exercise, prolonging exercise behavior. However, in this study, exercise barriers referred to the positive or negative tendency of participants' internal psychology to participating in exercise behavior, which was one of the im-portant factors limiting individual exercise behavior. In addition, the study did not in-clude extrinsic factors (exercise environment, work hours, peers, etc.) for exercise bar-riers in young females. Future studies measuring extrinsic factors in exercise barriers were warranted to demonstrate the effects of EC versus EB on BO in young females. Thou future research should include more objective measures of exercise behavior.

In this study, there might be many internal or external psychological factors that caused exercise barriers, which in turn affect the correlation between exercise cogni-tion and exercise behavior outcomes. In addition, diets using only advocacy data and coaching oral advocacy at the end of each experiment may also interfere with the re-sults, and these factors will be examined in future studies. The current research results show that exercise cognition was related to exercise behavior. In this regard, the link between exercise cognition and behavior should be emphasized to facilitate the pro-duction of exercise behavior outcomes. It is essential in promoting exercise behavior in young females.

Conclusion

This study, whether aerobic or anaerobic exercise intervention, could promote positive effects of exercise cognition, and these effects can also produce positive exer-cise behavioral outcomes. As discussed in this paper, exercise barriers might be re-sponsible for the decline in exercise behavioral outcomes, but it had also been con-firmed that exercise cognition and exercise barriers had unique effects on exercise be-havioral outcomes, which might be associated with lower negative psychological bar-riers before participating in exercise. The higher the explanatory power of behavioral outcomes. In fact, studies had shown that promoting exercise cognition in young fe-males, using aerobic or anaerobic exercise types, and excluding psychological exercise barriers, could trigger strong exercise behavioral outcomes.

Author Contributions

Conceptualization, W.K.C., P.H.W., and W.C.E.; Resistance training program and methodology, H.W.Y., W.K.C., and P.H.W.; software, W.C.E.; validation, W.K.C., and W.C.E.; formal analysis, P.H.W.; investigation, W.K.C.; re-sources P.H.W.; data curation, W.K.C., and W.C.E.; writing-original draft preparation, W.K.C.; writing-review and editing, P.H.W., W.K.C., and W.C.E.; supervision, W.K.C.; project administration, W.K.C. All authors have read and agreed to the published ver-sion of the manuscript.

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Institutional Review Board Statement

The study was conducted according to the guidelines of the Declaration of Helsinki and was approved by a local Institutional Re-view Board (protocol code 110-96).

Informed Consent Statement

Informed consent was obtained from all the participants in the study.

Data Availability Statement

The experimental results obtained actual data from the study participants before and after the training on measurement data. Participants agree with the data structure via a confirmation, and confirmation can be disclosed with reasonable availability. All datasets in this paper are available to editors, review-ers, and readers per request.

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Conflicts of Interest

The authors declare no conflict of interest.

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