The Effect of Aerobic Dance Program on Sustained Attention and Physical fitness of University Students

Ke Kuang[1], Tanida Julvanichpong[2], Chatkamon Singhnoy[3], Chairat Choosakul[4], Kanok Panthong[5] and Somporn Songtrakul[6]
[1,2,3,5,6]Burapha University, Thailand
[4]Mahasarakham University, Thailand
Corresponding Author, Email: 65910129@go.buu.ac.th

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Abstract

This study examines whether an 8-week aerobic dance program improves sustained attention and physical fitness in university students and whether significant differences exist between the experimental and control groups. Sixty female students from Huanghuai University in China were randomly assigned to either an experimental group (aerobic dance intervention) or a control group (maintaining regular activities). The experimental group participated in an 8-week, moderate-intensity aerobic dance program, with sessions held three times per week, each lasting 60 minutes. The experimental data will be collected for both the experimental and control groups through ANT and physical fitness tests at three time points: pre-intervention (Week 0), mid-intervention (Week 4), and post-intervention (Week 8). Sustained attention will be measured using the Attention Network Test (ANT), while physical fitness will be assessed according to the standards of the American College of Sports Medicine (ACSM，2021), encompassing cardiovascular endurance, muscular strength, muscular endurance, flexibility, and body composition. Collected data will be analyzed using SPSS Statistics 26, employing paired t-tests, independent t-tests, and one-way repeated measures MANOVA to evaluate differences between the groups.

The research results found significant improvements in both attention and fitness levels in the experimental group, particularly in reaction time and alertness ($p < 0.01$). Additionally, the experimental group showed notable improvements in the 800-meter run, 1-minute push-up count, and sit-and-reach flexibility ($p < 0.01$). This study demonstrates that an aerobic dance program positively impacts sustained attention and physical fitness, highlighting its potential as a valuable intervention for enhancing sustained attention and physical fitness in university students.

Keywords: Aerobic Dance; Sustained Attention; Physical Fitness; University Students

Introduction

Due to the widespread use of digital media and increasing academic pressure, university students are facing significant challenges in maintaining both sustained attention and physical health. Excessive media multitasking and sedentary lifestyles have contributed to the growing prevalence of attention deficits, particularly in sustained attention, which directly affects academic performance (Ophir, Nass, & Wagner, 2009). Simultaneously, rising obesity rates and declining physical fitness levels further emphasize the urgent need for comprehensive interventions that address both cognitive and physical health (Hou, 2017; Zhou, 2019).

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Physical activity, particularly aerobic programs, has shown promise in enhancing both sustained attention and physical fitness by improving cardiovascular health. Aerobic exercise not only benefits cognitive function through mood enhancement and neurogenesis but also boosts student engagement through interactive elements, effectively improving sustained attention and academic performance (Ratey & Loehr, 2011). However, research on the specific effects of aerobic dance on university students' sustained attention and physical fitness remains limited, underscoring a clear gap in the literature.

This study aims to investigate the effects of an aerobic dance program on sustained attention and physical fitness among university students. The specific research questions are as follows: (1) Do students who participate in the aerobic dance program exhibit significant improvements in sustained attention and physical fitness? (2) Are there significant differences in sustained attention and physical fitness between the experimental group and the control group? These questions will be addressed by comparing the performance of the experimental group (participating in the aerobic dance program) and the control group (maintaining regular physical education activities) across various assessment indicators, thereby examining the potential benefits of the aerobic dance program on students' physical fitness and sustained attention.

Research Objectives

1. To compare the sustained attention test results between Week 0 and Week 8 for both the experimental and control groups.
2. To compare the sustained attention test results between the experimental group and the control group at Week 8.
3. To compare the physical fitness test results between Week 0 and Week 8 for both the experimental and control groups.
4. To compare the physical fitness test results between the experimental group and the control group at Week 8.
5. To compare the sustained attention test results between the experimental and control groups across Weeks 0, 4, and 8.
6. To compare the physical fitness test results between the experimental and control groups across Weeks 0, 4, and 8.

Literature Review

1.Attention

Attention is a core cognitive process that enables individuals to selectively focus on important information while filtering out distractions (Unsworth & Robison, 2020). Sustained attention refers to the ability to maintain focus over extended periods, playing a crucial role in academic performance and daily tasks (Peng, 2018). Research suggests that interventions such as meditation, cognitive training, and focused activities can significantly enhance attention levels (Sumantry, 2021; Leśniak et al., 2020). Attention theory has evolved from early filter models (Broadbent, 1958) to modern attention network models, emphasizing the dynamic nature of attention involving multiple brain networks such as alertness, orientation, and executive control (Posner & Petersen, 1990). Sustained attention is defined as the ability to maintain goal-directed focus in low-stimulus environments (Robertson et al., 2010), relying on the collaboration of the prefrontal cortex and neurotransmitter systems (Rueda et al., 2015). Common measurement tools for sustained attention include the Sustained Attention Task (SAT) and the Attention Network Test (ANT), both of which provide objective assessments of attention levels (Oken et al., 2006).

2. Physical Fitness and Aerobic Dance

Physical fitness refers to an individual's ability to perform daily activities, encompassing cardiovascular endurance, muscular strength, and flexibility (Caspersen et al., 1985). Studies indicate that aerobic exercise not only significantly improves these fitness metrics but also positively affects cardiovascular and psychological health (Annadurai et al., 2021; Arfanda et al., 2022). Aerobic dance enhances cardiovascular function through rhythmic movements and promotes mental health through the incorporation of music and social interaction (American Council on Exercise, 2020). Aerobic dance significantly improves cardiovascular endurance (Domene et al., 2015; Vazou et al., 2016) and reduces stress while enhancing psychological well-being through emotional regulation (Koch et al., 2019). Furthermore, regular participation in aerobic dance improves the functioning of brain regions related to attention, particularly the prefrontal and parietal lobes, which are crucial for executive function and cognitive control (Qi, 2019). Aerobic exercise also promotes the release of brain-derived neurotrophic factor (BDNF), which fosters neurogenesis and enhances brain plasticity (Szuhany et al., 2015).

3.Attention and Physical Fitness in University Students

With the increasing use of digital devices and online media, attention issues among university students have become more prevalent. Studies show that frequent multitasking is strongly correlated with a decline in sustained attention performance (Wilmer et al., 2017). At the same time, declining physical fitness and rising obesity rates among university students underscore the urgent need for physical activity to improve both attention and fitness levels (Huffman et al., 2018). Therefore, comprehensive health interventions, particularly physical activities like aerobic dance, play a vital role in enhancing both the mental and physical health of university students, thereby improving their academic performance and overall well-being.

Research Methodology

The research methodology for this study, designed to assess the effects of an 8-week aerobic dance program on sustained attention and physical fitness among university students, is structured into several key components: population and sample, interventions, research tools, data collection, data analysis, and the conceptual framework.

1. Population and Sample

The study participants were first-year female students at Huanghuai University, aged 18 to 20, representing a typical university demographic not regularly engaged in physical activities or aerobic dance programs. A total of 60 healthy students with no prior experience in aerobic dance were selected through purposive sampling and randomly assigned to either the experimental group or the control group, with 30 participants in each. The sample size was determined using G*Power software to ensure a statistical power of 0.80, an effect size of 0.8, and a significance level of 0.05. The experimental and control groups were comparable in terms of age, height, and weight. The mean age in the experimental group was 18.67 ± 0.61 years, while the control group had a mean age of 18.93 ± 0.64 years; the experimental group’s average height was 163.27 ± 4.44 cm compared to 162.70 ± 4.12 cm in the control group; and the experimental group had an average weight of 55.12 ± 9.31 kg, while the control group averaged 54.09 ± 10.79 kg.

This study received ethical approval from the Burapha University Ethics Committee (Approval Number: G-HS046/2567(C1)), and informed consent was obtained from all participants before data collection, with participants informed of their right to withdraw from the study at any time.

2. Interventions (Experimental Procedure and Control Group Activities)

This study involved an experimental group that participated in an 8-week moderate-intensity aerobic dance program, while the control group maintained their regular daily activities without engaging in any additional structured physical exercise. Participants in the experimental group attended aerobic dance classes three times per week, with each session lasting 60 minutes. Classes were scheduled at fixed times to ensure consistency in training. All sessions were conducted on the campus sports field at Huanghuai University, which provided an open, well-ventilated environment suitable for the aerobic dance program, ensuring safe ground conditions.

Course Content:

Weeks 1-2: The warm-up included movements of the head, shoulders, chest, waist, legs, knees, wrists, and ankles, set to a tempo of 90-95 BPM, lasting 10 minutes. The training session incorporated marching in place, brisk walking, and jogging, with a tempo of 95-100 BPM, practiced by students at 105 BPM. The relaxation phase consisted of slow walking and stretching at a tempo of 80-85 BPM, also lasting 10 minutes.

Weeks 3-4: The warm-up was enhanced to include knee raises, arm circles, and leg swings, set to a tempo of 95-100 BPM, lasting 10 minutes. The training session introduced more complex dance combinations, such as cross steps and side kicks, practiced by students at 115 BPM. The relaxation phase involved deep breathing and stretches at a tempo of 85-90 BPM for 10 minutes.

Weeks 5-6: This phase included more challenging warm-up exercises, such as jumping jacks and squat jumps, at a tempo of 100-105 BPM, lasting 10 minutes. The training session incorporated even more complex movements, including side skips and squat jumps, practiced at 125 BPM. The relaxation phase focused on triceps and hamstring stretches at a tempo of 90-95 BPM for 10 minutes.

Weeks 7-8: The final two weeks featured advanced warm-up exercises, such as side jumps and trunk twists, at a tempo of 105-110 BPM, lasting 10 minutes. The training session included high-difficulty combinations, such as cross steps with box turns and knee-high jumps, practiced at 135 BPM. The relaxation phase included neck and shoulder stretches at a tempo of 95-100 BPM for 10 minutes.

Participants in the control group did not engage in any additional physical activities beyond their normal daily routines, which included regular academic and social activities, as well as light physical activities such as walking to and from classes. Regular check-ins were conducted to ensure that control group participants did not partake in any additional physical exercise, thereby maintaining the distinction between the experimental and control groups.

3.Research Tools

Two primary tools were employed to evaluate the effects of the intervention:

(1) Attention Network Test (ANT): Used to measure sustained attention, the ANT assesses key cognitive components: Alerting Effect，Orienting Effect，Conflict Effect，Mean Reaction Time，Cronbach’s alpha: 0.70-0.90。

(2) Physical Fitness Assessments: Physical fitness was evaluated using American College of Sports Medicine (ACSM, 2021) guidelines: Cardiovascular Endurance(800-meter run), Muscular Strength (grip strength dynamometer), Muscular Endurance (1minute push-ups), Flexibility (Sit-and-reach) and Body Composition(body fat percentage).

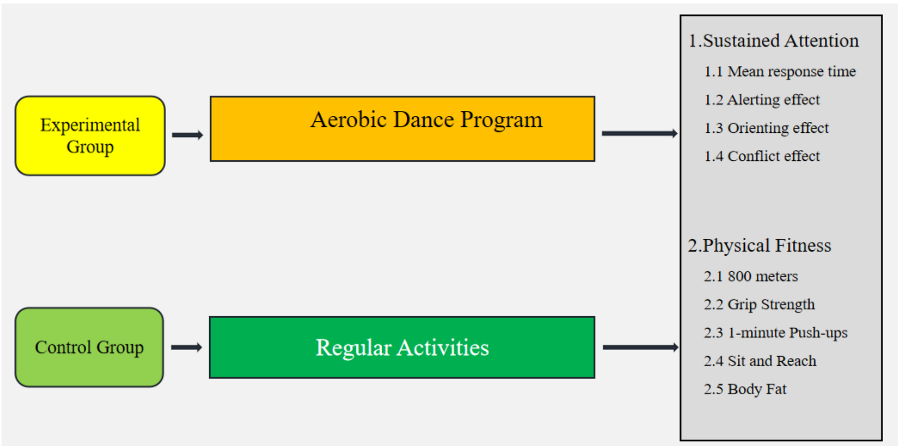
4. Data Collection

Data were collected at three time points: pre-intervention (Week 0), mid-intervention (Week 4), and post-intervention (Week 8). Baseline data were collected at Week 0, including ANT attention assessment and physical fitness tests (cardiovascular endurance, muscular strength, endurance, flexibility, and body composition). Reassessments were conducted at Week 4 to evaluate the immediate effects of the intervention, and at Week 8 to assess the cumulative effects of the 8-week aerobic dance program on attention and physical fitness.

5.Data Analysis

A paired t-test was used to examine within-group differences between Week 0 and Week 8 in both the experimental and control groups, while an independent t-test was conducted to assess between-group differences at Week 8. Additionally, a one-way repeated measures MANOVA was utilized to analyze data across Weeks 0, 4, and 8, investigating temporal changes and interaction effects between the experimental and control groups.

Research Conceptual Framework



This conceptual framework illustrates the intervention design. The experimental group participates in an 8-week aerobic dance program, progressively increasing in intensity. The control group continues with regular activities. The study aims to measure the impact on two key outcomes: sustained attention, assessed by four metrics, and physical fitness, evaluated through five tests.

Research Result

1. Paired T-Test Results for Sustained Attention Metrics Between Weeks 0 and 8

Table 1 To compare the sustained attention test results between Week 0 and Week 8 for experimental group.

	Variable	N	Mean	SD	df	t	p
Pair 1	Post-Mean response time	30	590.55	92.77	29	-4.984	0.000**
	Pre-Mean response time	30	692.88	105.39			
Pair 2	Post-Alerting	30	106.65	43.02	29	3.971	0.000**
	Pre-Alerting	30	77.27	58.73			
Pair 3	Post-Orienting	30	45.12	32.32	29	0.908	0.371
	Pre-Orenting	30	33.79	57.85			
Pair 4	Post-Conflicting	30	62.14	48.83	29	-3.978	0.000**
	Pre-Conflicting	30	102.36	75.39			

**p < 0.05, **p < 0.01*

Table 2 To compare the sustained attention test results between Week 0 and Week 8 for control group.

	Variable	N	Mean	SD	df	t	p
Pair 1	Post-Mean response time	30	619.77	112.68	29	0.086	0.932
	Pre-Mean response time	30	619.47	124.84			
Pair 2	Post-Alerting	30	59.33	41.20	29	-1.260	0.218
	Pre-Alerting	30	62.49	42.56			
Pair 3	Post-Orienting	30	28.69	35.48	29	0.053	0.958
	Pre-Orenting	30	28.60	35.09			
Pair 4	Post-Conflicting	30	88.93	48.92	29	0.262	0.795
	Pre-Conflicting	30	88.02	49.59			

**p < 0.05, **p < 0.01*

The paired T-test results for the experimental group (EG) between Weeks 0 and 8 revealed significant improvements in sustained attention metrics. The mean response time decreased markedly from 692.88 ms (SD = 105.39) at Week 0 to 590.55 ms (SD = 92.77) at Week 8 ($t(29) = -4.984$, $p < 0.01$), indicating a substantial reduction in reaction time. Additionally, the alerting performance showed a significant increase, with the mean rising from 77.27 (SD = 58.73) to 106.65 (SD = 43.02) ($t(29) = 3.971$, $p < 0.01$). Although no significant change was observed in the orienting metric, the conflicting task performance improved significantly, as the mean decreased from 102.36 (SD = 75.39) to 62.14 (SD = 48.83) ($t(29) = -3.978$, $p < 0.01$), demonstrating enhanced ability to handle conflict conditions; The control group showed no significant changes in any sustained attention metrics over the 8-week period.

2. Comparison of Sustained Attention Test Results Between Experimental and Control Groups at Week 8

Table 3 To compare the sustained attention test results between the experimental group and the control group at week 8.

Group	Variable	N	Mean	SD	df	t	p
EG	Mean response time	30	590.55	92.77	58	-1.097	0.277
CG	Mean reponse time	30	619.77	112.68			
EG	Alerting	30	106.65	43.02	58	4.351	0.00**
CG	Alerting	30	59.33	41.20			
EG	Orienting	30	45.12	32.32	58	1.875	0.066
CG	Orenting	30	28.69	35.48			
EG	Conflicting	30	62.14	48.83	58	-2.123	0.038*
CG	Conflicting	30	88.93	48.92			

*$p < 0.05$, **$p < 0.01$

At Week 8, an independent t-test showed that the experimental group (EG) significantly outperformed the control group (CG) in alerting (EG: M = 106.65, SD = 43.02; CG: M = 59.33, SD = 41.20; t(58) = 4.351, p < 0.01) and conflicting tasks (EG: M = 62.14, SD = 48.83; CG: M = 88.93, SD = 48.92; t(58) = -2.123, p < 0.05). These results demonstrate the effectiveness of the intervention in enhancing alerting and conflicting task performance in the experimental group.

3.Paired T-Test Results for Physical Fitness Metrics Between Weeks 0 and 8

Table 4 To compare the physical fitness test results between Week 0 and Week 8 for experimental group.

	Variable	N	Mean	SD	df	t	p
Pair 1	Post-800 meters(s)	30	224.40	16.48	29	-26.017	0.00**
	Pre-800 meters(s)	30	247.10	17.49			
Pair 2	Post-Grip Strength(kg)	30	28.31	3.57	29	29.940	0.00**
	Pre-Grip Strength(kg)	30	26.45	3.60			
Pair 3	Post-1-minute Push-ups(count）	30	11.40	2.95	29	25.107	0.00**
	Pre-1-minute Push-ups(count）	30	6.37	2.95			
Pair 4	Post-Sit and Reach(cm)	30	18.52	6.54	29	23.879	0.00**
	Pre-Sit and Reach(cm)	30	16.03	6.55			
Pair 5	Post-Body Fat (%)	30	19.78	3.65	29	-22.278	0.00**
	Pre-Body Fat (%)	30	22.88	3.87			

*$p < 0.05$, **$p < 0.01$

Table 5 To compare the physical fitness test results between Week 0 and Week 8 for control group.

	Variable	N	Mean	SD	df	t	p
Pair 1	Post-800 meters(s)	30	254.73	20.18	29	1.161	0.255
	Pre-800 meters(s)	30	254.33	20.30			
Pair 2	Post-Grip Strength(kg)	30	26.87	3.84	29	-1.511	0.142
	Pre-Grip Strength(kg)	30	26.90	3.83			
Pair 3	Post-1-minute Push-ups(count)	30	5.97	2.65	29	-3.751	0.001**
	Pre-1-minute Push-ups(count)	30	6.43	2.79			
Pair 4	Post-Sit and Reach(cm)	30	13.82	6.13	29	-0.469	0.642
	Pre-Sit and Reach(cm)	30	13.86	6.21			
Pair 5	Post-Body Fat (%)	30	21.99	3.33	29	1.930	0.063
	Pre-Body Fat (%)	30	21.88	3.42			

$^{*}p < 0.05$, $^{**}p < 0.01$

The paired T-test results for the experimental group (EG) between Weeks 0 and 8 revealed significant improvements across all physical fitness metrics. The 800-meter run time decreased significantly from 247.10 seconds (SD = 17.49) to 224.40 seconds (SD = 16.48) (t(29) = -26.017, p < 0.01). Grip strength increased from 26.45 kg (SD = 3.60) to 28.31 kg (SD = 3.57) (t(29) = 29.940, p < 0.01). The number of 1-minute push-ups improved significantly from 6.37 (SD = 2.95) to 11.40 (SD = 2.95) (t(29) = 25.107, p < 0.01). Flexibility, as measured by the sit and reach test, increased from 16.03 cm (SD = 6.55) to 18.52 cm (SD = 6.54) (t(29) = 23.879, p < 0.01). Body fat percentage also saw a significant reduction, decreasing from 22.88% (SD = 3.87) to 19.78% (SD = 3.65) (t(29) = -22.278, p < 0.01); For the control group (CG), a significant decrease was observed in the number of 1-minute push-ups, from 6.43 (SD = 2.79) to 5.97 (SD = 2.65) (t(29) = -3.751, p < 0.01).

4.Comparison of Physical Fitness Test Results Between Experimental and Control Groups at Week 8

Table 6 To compare the physical fitness test results between the experimental group and the control group at week 8.

Group	Variable	N	Mean	SD	df	t	p
EG	800 meters(s)	30	224.4	16.48	58	-6.377	0.00**
CG	800 meters(s)	30	254.73	20.18	58		
EG	Grip Strength(kg)	30	28.31	3.57	58	1.508	0.137
CG	Grip Strength(kg)	30	26.87	3.84	58		
EG	1-minute Push-ups(count)	30	11.4	2.96	58	7.504	0.00**
CG	1-minute Push-ups(count)	30	5.97	2.65	58		
EG	Sit and Reach(cm)	30	18.52	6.54	58	2.871	0.006**
CG	Sit and Reach(cm)	30	13.82	6.13	58		
EG	Body Fat (%)	30	19.78	3.65	58	-2.448	0.017*
CG	Body Fat (%)	30	21.99	3.33	58		

$^{*}p < 0.05$, $^{**}p < 0.01$

At Week 8, the experimental group significantly outperformed the control group in several physical fitness metrics. The experimental group completed the 800 meters faster (EG: M = 224.4, SD = 16.48; CG: M = 254.73, SD = 20.18; t(58) = -6.377, $p < 0.01$), and performed more push-ups (EG: M = 11.4, SD = 2.96; CG: M = 5.97, SD = 2.65; t(58) = 7.504, $p < 0.01$). Flexibility, measured by the sit-and-reach test, was also better in the experimental group (t(58) = 2.871, $p < 0.01$), with a lower body fat percentage compared to the control group (t(58) = -2.448, $p < 0.05$).

5.Analysis of one-way Repeated Measures MANOVA Results for Sustained Attention Measures

5.1 Assumptions Check for one-way repeated measures MANOVA

To test the assumption of sphericity for the one-way repeated measures MANOVA, Mauchly's test was performed. The results indicated significant deviations for all measures: Response Time (W = 0.595, $p < 0.01$), Alerting (W = 0.723, $p < 0.01$), Orienting (W = 0.434, $p < 0.01$), and Conflicting (W = 0.620, $p < 0.01$). Since the sphericity assumption was not met, the Greenhouse-Geisser correction was applied to adjust the degrees of freedom for the subsequent analyses.

5.2 Results of one way repeated measures MANOVA and Detailed Analysis of Between-Groups, Time, and Interaction Effects

Table 7 To compare the sustained attention test results between the experimental and control groups across weeks 0, 4, and 8.

Effect	Wilks' Lambda Statistic	F	df1	df2	P
Between-Group Effect	0.845	2.53	4	55	0.051
Time Effect	0.332	12.841	8	51	0.00**
Time × Group Effect	0.308	14.33	8	51	0.00**

**p < 0.05, **p < 0.01*

One way repeated measures MANOVA showed significant time effects for sustained attention measures, with performance improving significantly across all metrics from Week 0 to Week 8 (Wilks' Lambda = 0.332, F(8, 51) = 12.841, $p < 0.01$). Time × group interaction effects were significant (Wilks' Lambda = 0.308, F(8, 51) = 14.33, $p < 0.01$), indicating that the experimental group demonstrated greater improvements in sustained attention compared to the control group over time.

Table 8 Analysis of Between-Groups, Time, and Time × Group Interaction Effects on Various Measures.

Measurement	Comparison	F	p
Between-Group Effect			
Response	EG vs CG	1	0.321
Alerting	EG vs CG	6.57	0.013*
Orienting	EG vs CG	1.25	0.269
Conflicting	EG vs CG	0.16	0.695
Time Effect			
Response	Pre vs. Mid	1.77	0.189
	Mid vs. Post	33.386	0.00**
Alerting	Pre vs. Mid	1.13	0.292
	Mid vs. Post	11.13	0.001**
Orienting	Pre vs. Mid	0.113	0.738
	Mid vs. Post	5.346	0.024*
Conflicting	Pre vs. Mid	2.642	0.109
	Mid vs. Post	9.508	0.003**
Time × Group Effect			
Response	Pre vs. Mid	2.713	0.105
	Mid vs. Post	27.189	0.00**
Alerting	Pre vs. Mid	0.767	0.385
	Mid vs. Post	23.852	0.00**
Orienting	Pre vs. Mid	0.046	0.831
	Mid vs. Post	2.221	0.142
Conflicting	Pre vs. Mid	2.004	0.162
	Mid vs. Post	14.155	0.00**

$*p < 0.05$, $**p < 0.01$

The table presents the F-values and significance levels for the between-groups effects, time effects, and time × group interaction effects. A significant difference was observed between the experimental group (EG) and the control group (CG) in the alerting effect ($F = 6.57$, $p < 0.05$), indicating that the intervention had a notable impact on the alerting performance of the experimental group.

Main effect analysis revealed significant improvements in response time, alerting, and orienting from mid- to post-intervention (Response time: $F = 33.386$, $p < 0.01$; Alerting: $F = 11.130$, $p < 0.01$; Orienting: $F = 5.346$, $p < 0.05$), while no significant changes were found between pre- and mid-intervention. Conflict effect also improved significantly from mid- to post-intervention ($F = 9.508$, $p < 0.01$).

Time × group interaction effects showed that the experimental group demonstrated more pronounced improvements than the control group in response time, alerting, and conflict effects (Response time: $F = 27.189$, $p < 0.01$; Alerting: $F = 23.852$, $p < 0.01$; Conflict effect: $F = 14.155$, $p < 0.01$). These findings indicate that the intervention had a significant impact on the experimental group's sustained attention and conflict resolution abilities, with the most pronounced effects observed in the later stages of the intervention.

6.Analysis of one-way Repeated Measures and MANOVA Results for Physical Fitness Measures

6.1 Assumptions Check for one-way repeated measures MANOVA Mauchly's test indicated significant deviations from sphericity for all measures ($p < 0.01$). Therefore, the Greenhouse-Geisser correction was applied for 800 meters, Grip Strength, 1-minute Push-ups, and Sit and Reach ($W < 0.75$). For Body Fat ($W > 0.75$), the Huynh-Feldt correction was used.

6.2 Results of MANOVA and Detailed Analysis of Between-Groups, Time, and Interaction Effects

Table 9 To compare the physical fitness test results between the experimental and control groups across weeks 0, 4, and 8.

Effect	Wilks' Lambda Statistic	F	df1	df2	P
Between-Group Effect	0.710	4.415	5	54	0.00**
Time Effect	0.024	202.607	10	49	0.00**
Time × Group Effect	0.021	233.326	10	49	0.00**

**p* < 0.05, ***p* < 0.01*

The results of the one-way repeated measures MANOVA indicated significant improvements in all physical fitness measures over time (Wilks' Lambda = 0.024, $F(10, 49) = 202.607$, $p < 0.01$), along with a notable group effect (Wilks' Lambda = 0.710, $F(5, 54) = 4.415$, $p < 0.01$). Additionally, the time × group interaction effect was significant (Wilks' Lambda = 0.021, $F(10, 49) = 233.326$, $p < 0.01$), suggesting that the experimental group experienced greater enhancements in physical fitness over time compared to the control group, thereby highlighting the pronounced impact of the intervention on the experimental group.

Table 10 Analysis of Between-Groups, Time, and Time × Group Interaction Effects on Various Measures

Measurement	Comparison	F	p
Between-Group Effect			
800 meters (s)	EG vs CG	16.314	0.00**
Grip Strength (kg)	EG vs CG	0.368	0.546
1-minute Push-ups	EG vs CG	15.929	0.00**
Sit and Reach (cm)	EG vs CG	4.617	0.036*
Body Fat (%)	EG vs CG	0.543	0.464
Time Effect			
800 meters (s)	Pre vs. Mid	265.365	0.00**
	Mid vs. Post	422.325	0.00**
Grip Strength (kg)	Pre vs. Mid	501.573	0.00**
	Mid vs. Post	328.653	0.00**
1-minute Push-ups	Pre vs. Mid	121.800	0.00**
	Mid vs. Post	328.107	0.00**
Sit and Reach (cm)	Pre vs. Mid	279.041	0.00**
	Mid vs. Post	198.901	0.00**
Body Fat (%)	Pre vs. Mid	224.155	0.00**
	Mid vs. Post	148.985	0.00**
Time × Group Effect			
800 meters (s)	Pre vs. Mid	358.800	0.00**
	Mid vs. Post	343.254	0.00**
Grip Strength (kg)	Pre vs. Mid	658.761	0.00**
	Mid vs. Post	255.001	0.00**
1-minute Push-ups	Pre vs. Mid	300.771	0.00**
	Mid vs. Post	261.000	0.00**
Sit and Reach (cm)	Pre vs. Mid	305.045	0.00**
	Mid vs. Post	198.901	0.00**
Body Fat (%)	Pre vs. Mid	292.468	0.00**
	Mid vs. Post	147.563	0.00**

*$p < 0.05$, **$p < 0.01$

The between-group analysis revealed significant differences between the experimental and control groups in the 800-meter run ($F = 16.314$, $p < 0.01$) and 1-minute push-ups ($F = 15.929$, $p < 0.01$), indicating notable performance disparities in these measures. Additionally, the sit-and-reach test also showed a significant difference ($F = 4.617$, $p < 0.05$); The time effect analysis demonstrated significant changes across all physical fitness measures, with the 800-meter run, grip strength, 1-minute push-ups, sit-and-reach, and body fat percentage showing significant improvements at each stage of the intervention ($p < 0.01$); The time × group interaction effects were also significant across all physical fitness measures, indicating that the experimental group showed greater improvements over time compared to the control group, particularly in the 800-meter run, grip strength, 1-minute push-ups, sit-and-reach, and body fat percentage ($p < 0.01$).

Discussion

1. To compare the sustained attention test results between Week 0 and Week 8 for both the experimental and control groups.

The paired T-test results confirmed the positive effect of the aerobic dance program on sustained attention. The experimental group showed significant improvements in mean response time , alerting performance and conflict resolution (all $p < 0.01$), while no significant changes were observed in the control group. These results suggest that aerobic dance had a notable impact on cognitive functions related to sustained attention, particularly alertness and conflict resolution. Aerobic exercise is known to enhance cognitive performance by increasing blood flow and oxygen to key brain areas, such as the prefrontal cortex, which is crucial for attention and executive function (Colcombe & Kramer, 2003). The improvements in the experimental group likely reflect the benefits of aerobic exercise on attention networks (Hillman et al., 2009) and the role of brain-derived neurotrophic factor (BDNF) in enhancing attention through physical activity (Liu et al., 2020).

2. To compare the sustained attention test results between the experimental group and the control group at week 8.

Further analysis revealed that the experimental group showed significantly greater improvements in sustained attention by week 8 compared to the control group, whose progress was relatively minor. This indicates that while both groups improved, the aerobic dance intervention had a more pronounced effect on the experimental group. These findings are consistent with previous research showing that individuals who engage in aerobic exercise tend to perform better on attention tasks (Best, 2010). The improvement may be attributed to increased blood flow to the brain and enhanced neuroplasticity, both of which contribute to cognitive enhancements. The significant improvements in the experimental group highlight the potential of aerobic dance in enhancing cognitive abilities, particularly among university students.

3. To compare the physical fitness test results between Week 0 and Week 8 for both the experimental and control groups.

The paired T-test results confirmed the significant positive impact of the aerobic dance program on physical fitness. All physical fitness metrics in the experimental group showed significant improvements, whereas changes in the control group were limited. The only significant improvement in the control group was an increase in the number of 1-minute push-ups ($p < 0.01$), while other metrics showed no significant improvement over the 8-week period. This indicates that the level of physical fitness improvement in the control group was not as pronounced as in the experimental group. The increase in the number of push-ups in the control group may reflect a slight improvement in basic fitness or an adaptive response. Although they did not undergo specific fitness interventions, daily activities or light physical activity may have contributed to enhancing upper body muscle endurance. However, the stagnation in other physical fitness metrics suggests that this improvement was limited, primarily focused on specific muscle endurance.

These findings highlight the effectiveness of the aerobic dance intervention in improving the physical fitness of the experimental group, particularly in terms of cardiovascular endurance and body fat. This finding is consistent with existing literature, which indicates that regular aerobic exercise plays a crucial role in enhancing physical fitness parameters (Garber et al., 2011).

4. To compare the physical fitness test results between the experimental group and the control group at week 8.

The experimental group showed significantly greater improvements in cardiovascular endurance, muscle strength, and flexibility, while the progress in the control group was limited. This suggests that the time factor alone cannot explain the significant progress in the experimental group, further demonstrating the effectiveness of the aerobic dance program. These findings are consistent with previous research, indicating that full-body exercises like aerobic dance can better improve multiple physical fitness indicators (Wang et al., 2023). Therefore, aerobic dance is an effective way to enhance physical fitness among university students.

5. To compare the sustained attention test results between the experimental and control groups across weeks 0, 4, and 8.

This study compared sustained attention between the experimental and control groups at weeks 0, 4, and 8. The experimental group showed significant improvements in alerting effect, response time, and conflict effect, especially between weeks 4 and 8, where they significantly outperformed the control group. In contrast, the control group’s progress was limited.

One-way repeated measures MANOVA showed significant time effects and interactions between time and group ($p < 0.01$), indicating that the experimental group’s attention improved more over time, particularly in the later stages of the intervention. No significant differences were observed in the early phase (week 0 to week 4), which is common in cognitive interventions. However, from week 4 to week 8, the experimental group’s alerting effect increased significantly ($p < 0.01$), supporting the cumulative benefits of aerobic exercise (Colcombe & Kramer, 2003; Hillman et al., 2009). The experimental group also outperformed the control group in conflict effect ($p < 0.01$), aligning with research on aerobic exercise improving prefrontal cortex function (Voss et al., 2011). Overall, this study confirms that aerobic dance enhances sustained attention in university students, especially in later stages, validating the cognitive benefits of regular exercise.

6. To compare the physical fitness test results between the experimental and control groups across weeks 0, 4, and 8.

This study employed one-way repeated measures MANOVA to analyze changes in physical fitness between the experimental and control groups across weeks 0, 4, and 8. The results revealed that the group effect, time effect, and the interaction between time and group were all significant ($p < 0.01$), indicating substantial improvements in various fitness measures in the experimental group post-intervention. Specifically, the experimental group showed significantly greater enhancements in the 800-meter run, 1-minute push-up, and sit-and-reach flexibility tests compared to the control group, underscoring the efficacy of aerobic dance in enhancing endurance, muscular endurance, and flexibility.

Previous studies indicate that moderate-intensity aerobic exercise can significantly improve muscular endurance over a sustained period, which is consistent with the improvements observed in the push-up test in this study (Gordon, Benson, & Hsu, 2017). Regarding flexibility, Colcombe and Kramer (2003) found that aerobic exercise significantly enhances flexibility and range of motion, aligning with the improvements in the sit-and-reach test observed here. Moreover, the positive impact of aerobic exercise on cardiorespiratory endurance has been supported by other studies, such as a randomized controlled trial on long

COVID patients, which demonstrated that aerobic exercise significantly increased VO2 peak and overall cardiorespiratory endurance (Bai et al., 2024).

In contrast, the non-significant group effect on grip strength ($p = 0.546$) suggests that the intervention had limited efficacy in this area, consistent with findings by Timmons et al. (2018), who reported that strength training is more effective in improving metrics like grip strength. Furthermore, although body fat percentage showed a significant time effect ($p < 0.01$), the non-significant group effect ($p = 0.464$) suggests that short-term interventions may have a limited impact on body fat. This is in line with Swift et al. (2014), who found that clinically significant reductions in body weight and fat typically require at least 12 weeks of intervention.

Overall, these results suggest that while aerobic dance interventions are effective in improving endurance, muscular endurance, and flexibility, they have limited short-term effects on grip strength and body fat percentage.

Conclusion

This study demonstrates that an 8-week aerobic dance program significantly enhanced sustained attention and physical fitness among university students. The experimental group exhibited notable improvements in reaction time, alertness, and conflict resolution abilities, as well as significant progress in physical fitness metrics such as the cardiovascular endurance, strength endurance and flexibility. These findings suggest that aerobic dance effectively enhances cognitive functions associated with sustained attention and contributes to improved physical health.

Suggestions

1. Theoretical Suggestions

Expand Research Scope: This study primarily focuses on first-year female university students in China. Future research should broaden the sample to include students of different genders, age groups, and cultural backgrounds to validate the effects of aerobic dance on sustained attention and physical fitness across a wider demographic.

Extend Intervention Duration: Extending the intervention period would allow for the exploration of the long-term impacts of aerobic dance. Future studies could also incorporate additional cognitive assessments, such as working memory and executive function tests, to provide a more comprehensive evaluation of the cognitive benefits of aerobic exercise.

2. Policy Suggestions

Integrate Aerobic Dance into Curriculum: It is recommended that universities incorporate aerobic dance into their compulsory physical education curriculum to enhance students' attention and health.

Promote Aerobic Dance in Public Health: Governments and health organizations should promote aerobic dance in public health policies, particularly for university students, to help them maintain physical and mental well-being under academic pressure.

3. Practical Suggestions

Develop Integrated Health Programs: Universities could develop comprehensive health management programs that combine attention training with physical exercise to improve students’ performance in both academics and daily life.

Introduce Online Courses with Wearable Technology: Future initiatives could introduce online aerobic dance courses equipped with wearable technology, allowing students to train anytime, anywhere, while tracking their improvements in attention and physical fitness.

4. Suggestions for Further Research

Broaden Demographic Variables: Further research should consider a wider range of demographic variables to better understand the effects of aerobic dance across different populations.

Investigate Long-term Effects: Future studies should examine the long-term effects of aerobic dance on sustained attention and physical fitness, using additional assessment tools to validate the sustained impact.

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