

**EÖTVÖS LORÁND UNIVERSITY
FACULTY OF EDUCATION AND PSYCHOLOGY**

DOCTORAL SCHOOL OF EDUCATION

**THE INTERACTION BETWEEN PHYSICAL ACTIVITY AND
SLEEP QUALITY, STRESS AND LIFE SATISFACTION AMONG
ADULTS ---Aerobic Walking Intervention**

DISSERTATION BOOKLET



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1 Introduction

Epidemiological research highlighted the health benefits of physical activity in reducing disease risks (Wannamethee & Shaper, 2001). In young adults, there is a growing number of evidences showing that physical inactivity may be a preventive factor for multiple adverse health outcomes (Thorp, Owen, Neuhaus, & Dunstan, 2011). Physical activity is emphasized in the health promotion sector and plays a role in facilitating policy makers and health professionals who are interested in health surveillance at national and international levels (Brown et al., 2003). However, individuals' physical activity level is more likely to decrease after a certain period of time and their physical activity habits are significantly influenced by life-changing events (Dai, Wang, & Morrison, 2014). Feasible leisure-time physical activity implementations are highly requested for global health promotion to achieve consistent health outcomes.

Sleep quality, stress level and life satisfaction are three indicators for public health promotion. Physical activity is recognized to be influential on sleep health (Zee & Turek, 2006). Therefore, the relationship between physical activity and sleep quality is essential to be discussed. Considering the health implications and health care functionality, it is recommended that sleep disorders be prevented by health promotion strategies rather than by taking medical treatment. Consequently, given the health benefits of physical exercise, to explore the sleep benefits of physical exercise is of scientific interest to reduce health symptoms caused by disordered sleep. Psychology trials acknowledged physical activity to be a strategy for managing stress. However, measuring physical activity and quantifying the appropriate intensity/volume of physical activity for general young adults is still unclear. Hence, further actions are required to quantify physical exercise instruction in instructing stress release among young adults. Physical exercise is supposed to be positively associated with life satisfaction. Even though physical activity is considered to be a valuable tool for enhancing life satisfaction, feasible and instructive physical activity recommendations for health strategy at a population level are under discovery.

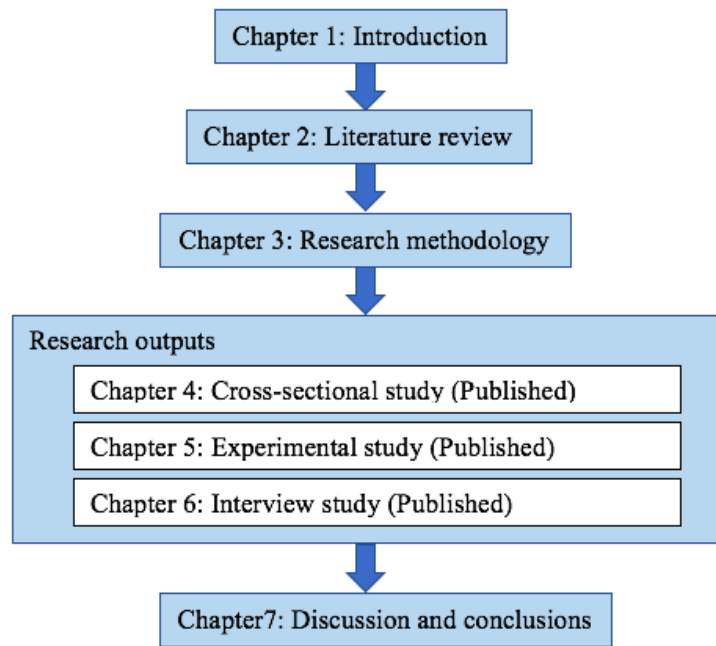


Figure 1 Structure overview of the dissertation

The doctoral research aims 1) to figure out the comprehensive relationships between sleep quality, stress and life satisfaction; 2) to examine the effectiveness of the designated aerobic walking exercise on sleep quality, stress and life satisfaction; 3) to explore the potential cognitive interactions of physical exercise on sleep quality, stress and life satisfaction. The structure overview of the dissertation is illustrated by Fig. 1.

2 Research questions & methods

The dissertation included three studies. Firstly, a cross-sectional study was conducted to examine the relationship between the three main variables in this dissertation (sleep quality, stress and life satisfaction). Secondly, a pedometer-based physical exercise (aerobic walking) intervention was conducted to investigate the effect of a daily walking exercise on sleep quality, stress and life satisfaction. Last but not least, an interview study was conducted to explore the cognitive outcomes and feedback from the research participants. Fig.2 provides a graphic overview of the mixed-method research design applied in the present dissertation, including research questions tailored to each study.

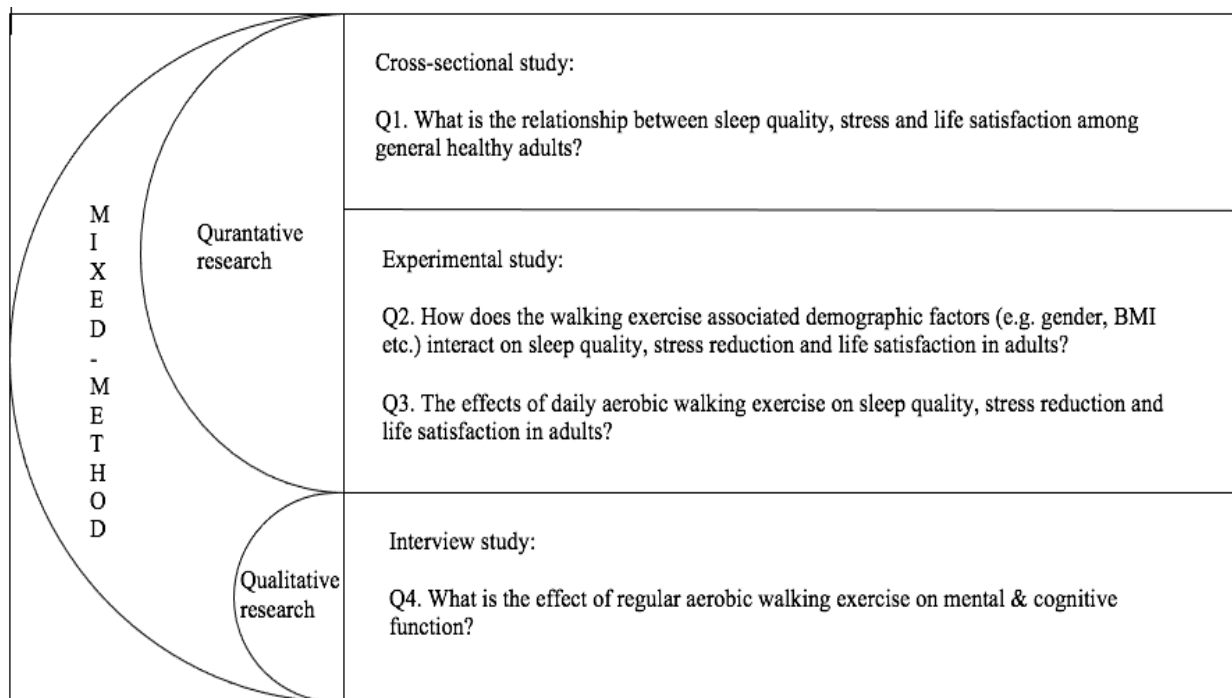


Figure 2 Overview of the structure of the dissertation

3 Studies & findings

Study 1

Study 1 presents a quantitative study, which addressed the association between physical activity and sleep quality. A cross-sectional study was conducted with the purpose of answering research question 1 by examining the relationship between sleep quality, stress and life satisfaction and comparing the difference associated with age and gender together with lifestyle factors (Wang & Boros, 2019).

Findings

The participants' mean age were at the end of their twenties at males ($M=29.12$, $SD=7.72$) and females ($M=28.73$, $SD=7.47$). In addition, the number of married or living cohabiting relationship is slightly less than the number of single participants for men 35/106(33%) and women 74/186(40%). The number of people who work and study were approximately the equal in the current study (men: 50/106(49%), women: 85/186(46%)). Approximately seven out of ten participants had physical activity less than 150 minutes per week with physical exercise volume $M=112.02$ ($SD=129.66$) minutes per week. It is statistically significant that males ($M=146.37$, $SD=155.52$) do more exercise than females ($M=93.85$, $SD=109.84$) per week

($p < .001$). In addition, a majority of people (69.9%) suffering moderate stress, small amount of people (5.5%) was in high perceived stress, and low percentage (24.7%) of people reported low stress. Females ($M=17.71$, $SD=6.06$) present much severer perceived stress than males ($M=16.42$, $SD=5.70$). The results showed that, males ($M=4.62$, $SD=1.48$) were more satisfying with life than females ($M=4.53$, $SD=1.69$). The mean score of PSQI for male is 5.70 ($SD=3.21$) and female is 5.13 ($SD=3.08$) with more good sleepers (60.3%) than bad sleepers (30.7%) in the sample.

Table 1 The correlations between physical activity volume, stress, life satisfaction and sleep quality by bivariate correlation analysis

		Physical activity	Stress	Life satisfaction	Sleep quality
Physical activity	Pearson Correlation	1			
	Sig. (2-tailed)				
Stress	Pearson Correlation	-.07	1		
	Sig. (2-tailed)	.27			
Life satisfaction	Pearson Correlation	.10	-.34**	1	
	Sig. (2-tailed)	.09	.00		
Sleep quality	Pearson Correlation	-.01	.26**	-.14*	1
	Sig. (2-tailed)	.9	.00	.01	

**Correlation is significant at the 0.01 level (2-tailed).

*Correlation is significant at the 0.05 level (2-tailed).

Table 2 The associations between physical activity volume, stress, life satisfaction and sleep quality by linear regression

Model	Unstandardized coefficients		Standardized coefficients		Sig.	95% Confidence interval for β	
	B	Std. Error	Beta	t		Lower bound	Upper bound
Physical volume	.000	.001	.009	.165	.869	-.002	.003
Stress	.228	.033	.436	6.944	.000	.164	.293
Life satisfaction	-.026	.031	-.052	-.827	.409	-.087	.035

Stress and life satisfaction are correlated with each other with statistical significance ($p < .001$), and both stress ($p < .001$) and life satisfaction ($p < .05$) are significantly correlated with sleep quality. According to the results of linear regression, only stress was statistically negatively associated with sleep quality with a relatively high predictive power ($p < .001$, $SE = .03$, $B = .43$), life satisfaction did not show predictive power ($Beta = .009$) with sleep quality. Physical activity did not show any significance with sleep quality ($p > .05$) in statistical analysis. See Table 1&2.

Table 3 The difference of life satisfaction/perceived stress/sleep quality between people who live in sedentary and non-sedentary life status by independent t-test

Variables	Non-sedentary group (n=76)		Sedentary group (n=186)		Sig.	95%CI		Effect size (Cohen's d)
	M	SD	M	SD		Lower	Upper	
Life satisfaction	4.77	1.57	4.22	1.65	.02	-.98	-.11	.48
Perceived stress	1.74	.52	1.88	.51	.04	.01	.28	-.27
Sleep quality	1.37	.48	1.43	.50	.41	-.08	.19	-.12

By defining people who do not do physical activity as sedentary group, people who do physical activity as non-sedentary group (exercise volume more than 150 minutes per week). The results (see Table 3) showed that life satisfaction ($p = .02$, Cohen's $d = .48$) and perceived stress ($p = .04$, Cohen's $d = -.27$) are significantly different between people who do physical activity and who do not. No significant association was found in sleep quality between sedentary lifestyle and non-sedentary lifestyle ($p > 0.05$, Cohen's $d = -.12$).

Summary

Study 1 shows the context of physical activity and stress, life satisfaction and sleep quality and the association between indicated that attention should be paid to age and gender. Demographic indicators and lifestyle habits are important in physical exercise research. It was indicated that moderate stress is prevalent among general adults and was significantly correlated with sleep quality. Sedentary lifestyle is not beneficial for life satisfaction, and people who carry on a sedentary lifestyle are more easily stressed. The results of this study suggested to explore specific physical activity types that can be beneficial for stress, sleep and life satisfaction. This

study highlighted the necessity of promoting physical exercise levels among adults and unfolded several research issues in health promotion interventions.

Study 2

Study 2 presents the investigation of the designated daily aerobic walking intervention on sleep quality, stress and life satisfaction (Wang & Boros, 2021a). The intervention study is a randomized controlled cross-over study. Randomized controlled cross-over study is a combination of crossover trial and randomized controlled trial. The whole intervention process lasted for 12 weeks in total, in which two groups of participants exchanged their roles for active intervention (see Fig. 3). Omron HJ-112 pedometer was used to facilitate the intervention process. The intervention study answers the research question 2 & 3. Participant selection and intervention procedures are fully interpreted to affirm the quality of the experiment.

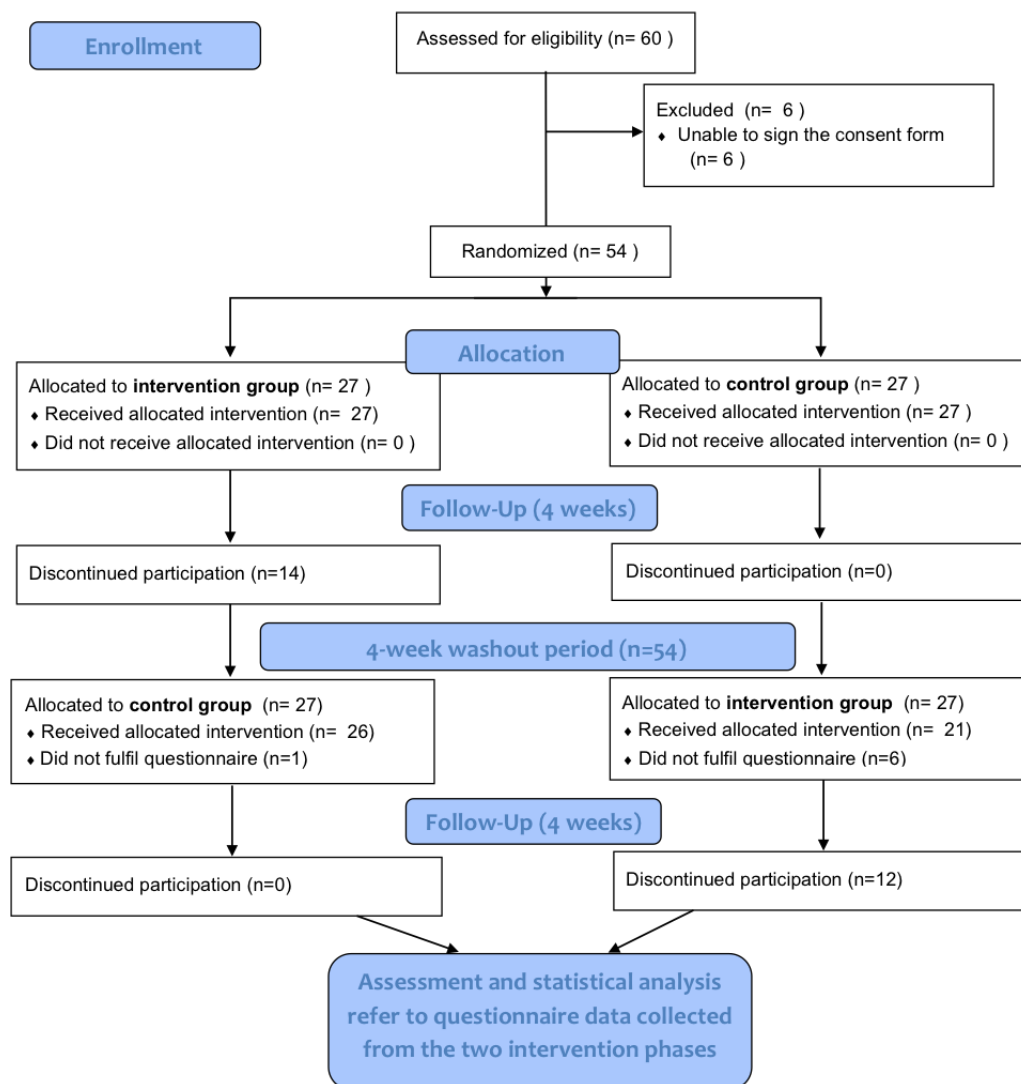


Figure 3 The intervention process of the randomized cross-over trial

Findings

Results were analyzed using nonparametric tests for two reasons: (a) the assumption of normality was violated in the data and (b) the sample size was relatively low as based on the design sample size calculation with G* Power software (Faul, Erdfelder, Lang, & Buchner, 2007). To test the hypothesis that the walking intervention had an effect on the dependent measures, Wilcoxon Signed-Rank tests were used separately for the control- and intervention group. The results are summarized in Table 4. The pre-post comparison indicated that regular aerobic walking exercise showed beneficial outcomes in improving sleep quality, stress and life satisfaction.

Table 4 Results of the Wilcoxon Signed Rank Tests testing the changes over one month in the Intervention- (walking) and Control group (no walking)

Group	Measure	Time	N	M (SD)	Z	p	r
Intervention	PSQI	Pre-	22	5.27 (3.01)	-3.08	.002	-.46
		Post-	22	3.59 (2.30)			
	LS	Pre-	22	25.4 (5.6)	-2.93	.003	-.42
		Post-	27	28.3 (5.76)			
	PSS	Pre-	22	6.77 (2.78)	-2.68	.007	-.38
		Post-	27	5.52 (2.42)			
Control	PSQI	Pre-	24	5.12 (2.98)	-1.47	.141	-0.21
		Post-	25	4.56 (2.38)		(NS)	
	LS	Pre-	22	23.9 (6.36)	-2.94	.003	-.43
		Post-	24	27.0 (5.35)			
	PSS	Pre-	24	6.0 (2.70)	-.652	.051	-0.94
		Post-	24	6.17 (2.35)		(NS)	

Note: Dependent measures are: PSQI = Pittsburgh Sleep Quality Index; LS = Life Satisfaction; PSS = Perceived Stress. The effect size (r) is indicated in the last (far right) column. NS = Not Significant.

Statistically significant ($p < 0.05$) correlation between delta SPQI and change in perceived stress was found. Alcohol consumption showed a positive correlation ($p < 0.05$) with the PSQI (see Table 5). In addition, comparisons were made to examine the magnitude of changes during the one-month interval between men and women. These results revealed that

there were statistically no significant differences between sexes in term of sleep quality, stress and life satisfaction (see Table 6).

Table 5 Means, Standard deviations and Spearman correlation matrix of measured variables (N = 54)

Variables	Mean	SD	2	3	4	5	6	7	8
1 Age	24.28	4.55	-.142	.107	-.053	-.176	-.153	-.003	-.172
2 BMI	22.39	3.06	1.00	-.103	.190	.281*	.021	-.180	-.055
3 Coffee	1.53	0.87		1.00	.303*	.150	-.063	-.102	-.039
4 Alcohol	2.03	0.99			1.00	.062	.319*	-.257	.158
5 Smoking	1.57	1.16				1.00	.007	-.059	.092
6 Delta PSQI	-1.31	2.49					1.00	.021	.330*
7 Delta LS	3.30	4.37						1.00	.145
8 Delta PS	-1.00	2.34							1.00

*Note: *Correlation is significant at the 0.05 level (2-tailed). PSQI = Pittsburgh Sleep Quality Index; LS = Life Satisfaction; PS = Perceived Stress*

Table 6 Comparison of sleep quality, life satisfaction and perceived stress between males and females

	gender	N	Mean Rank	Z	p	η^2
Delta PSQI	male	7	15.43	-1.956	.051	0.182
	female	15	9.67			
Delta Life Satisfaction	male	7	12.07	-.562	.57	0.016
	female	14	10.46			
Delta Perceived Stress	male	7	10.79	-.114	.909	0.001
	female	14	11.11			

Note: Grouping Variable: gender; η^2 = effect size

Summary

Study 2 shows an expected trend of walking exercise intervention in stress, sleep quality and life satisfaction, which indicated that walking exercise was an effective strategy among young adults. The results of this study appealed that when physical exercise is expected to improve life functions and daily activity, regularity and continuity of exercise should be emphasized.

This study implemented the aerobic walking exercise intervention by organizing a walking research program, which was orientated, regulated, structured and supervised.

Study 3

Study 3 discloses research question 4 by a qualitative study, which intended to search for the interactions between regular aerobic walking exercise and mental health construction (Wang & Boros, 2021b). A semi-structured interview study was conducted with the research participants who completed the aerobic walking intervention in study 2. The findings of the interview study are not limited to the psychological outcomes of the regular aerobic walking exercise but also an overall assessment of the intervention. Clues are drawn from three angles: efficacy of the intervention, feasibility of the intervention and cognitive feedback.

Findings

The interview data summarized in this study redefined the terminology of aerobic walking. The walking exercise was categorized into four perspectives considering intervention itself, process control, motivations of the participants and the achievements. Table 7 summarizes the concepts of aerobic walking regarding the answers of the participants.

Table 7 Categories and key issues of the aerobic walking intervention

Category	Key issues	Example statements
Intervention	Easy walking; with friends; without thinking; explore neighborhood	<p><i>"It's efficient in the way that you keep away your mind from the classes, from the daily routine. You just enjoy your walking and just looking for the people or just looking around."</i></p> <p><i>"It is like you're walking and trying to empty your mind and try to focus. So, it's like a meditative experience. Like I let out my emotions"</i></p>
Process control	Time management; pedometer effect, weather condition	<p><i>"The walking itself is not difficult, to find the time every day is difficult".</i></p> <p><i>"I was very surprised when I use this pedometer, because I could follow my daily</i></p>

		<i>walking steps. I thought that I was collecting my exercise and I walked a lot.”</i>
Self-motivation	Interest; credits; need for exercise; get back to sleep, competition	<i>“It is not a burden, but a time for entertainment. A time for myself.”</i> <i>“It was energetic. It was kind of competition affected.”</i>
Achievements	Feeling of achievement; Ability to manage time;	<i>“I think it was good because I felt that I could really manage my life.”</i> <i>“It's the feeling of success that gives you more motivation to do all your to do list in the day.”</i> <i>“When I go for a walk, it makes me feel much better. I come back with a clear mind that makes me feel good.”</i>

Several reports tailored to the effect of aerobic walking on sleep quality, stress management and life satisfaction from the analysis were listed below. Table 8 shows the concepts of sleep quality, stress and life satisfaction before and after intervention period by thematic terms. The statements presented in Table 8 are a summary of the key concepts from the interviewees. The table is an outlook of sleep, stress and life satisfaction before and after the walking program.

Table 8 Concepts of sleep quality, stress and life satisfaction before and after intervention period

	Sleep quality	Stress	Life satisfaction
Before intervention	Unable to sleep; irregular sleep;	Miserable feeling; bear with the stress	Life is stressful; want to change life;
After intervention	Wake up fresher; sleep quickly and deeply, relaxed; longer duration	Relaxed; helpful; Good for mood; meditate problems, peaceful, rethink things, alleviate distress; released	Proud of my life; Feeling of success; Able to manage daily routine; motivated

Summary

This interview study tried to explore how aerobic walking would be beneficial for sleep quality, stress management and life satisfaction. Aerobic walking helps to facilitate sleep process in term of sleep depth, sleep latency between bad sleepers. Stress can be risk factor for poor sleep quality and life satisfaction. Integrated effects were found during walking onset. For instance, the meditative effect behind brisk walking could release the stress level and maintain a peaceful moment. The walking exercise cannot solve the problem that caused stress, but it helps to rethink and calm down. Life satisfaction can be violated by many factors happens in life, with the same rational, walking exercise can play a role in ameliorating rather than curing dilemmas.

4 Implications & justification

The findings of the present dissertation that to discover the effectiveness of a particular type of daily aerobic walking activity on sleep quality, stress and life satisfaction provided specific suggestions for health intervention and health promotion strategies. A walking-friendly environment is essential for facilitating the walking activity. The use of determined walking has great psychological implications including nurturing cognition and meditative effect. Study 1 highlighted the interacted relationship between sleep quality, stress and life satisfaction. Study 2 deliberated the effectiveness of walking on sleep quality, stress and life satisfaction individually. Study 3 made a further investigation on the psychological reactions of goal-setting walking activity. These evidences enhanced the positive effects of walking exercise and supplemented the research in walking activity among the healthy adult population. In addition, the findings in the dissertation play a key role in calling attention from policy makers, researchers and health educators to develop easily accessible/implementable health recommendations.

5 Future work

The results of this dissertation can be applied to promoting the health status and sleep status of the overall population and encourage society to behave actively and reduce the health and economic burden caused by poor physical and sleep health. Doing physical exercise on regular basis requires time management ability, perseverance, motivation etc., of which the cognitive

outcome may be different from doing spontaneous physical exercise. Therefore, for people who are in sedentary and irregular exercise life style, which are unhealthy, to maintain the regularity of physical exercise might positively influence their life habits. Thus, it would be valuable to evaluate feasible and regulated physical exercise to promote the health status and examine the consistency of the health outcomes. In addition, the mechanism between visual effects and cognitive functions in body movement is suggested for exploration.

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