VOLUME 65 - No. 4 - APRIL 2025


THE JOURNAL OF SPORTS MEDICINE AND PHYSICAL FITNESS






PUBBLICAZIONE PERIODICA MENSILE - POSTE ITALIANE S.P.A. - SPED. IN A. P. D.L. 353/2003 (CONV. IN L. 27/02/2004 N° 46) ART. 1, COMMA 1, DCB/CN - ISSN 0022-4707 TAXE PERCUE

PUBLISHED BY MINERVA MEDICA

Online version at https://www.minervamedica.it

The Journal of Sports Medicine and Physical Fitness 2025 April;65(4):583-97
DOI: 10.23736/S0022-4707.24.16237-8

ORIGINAL ARTICLE

PSYCHOLOGY

Effects of eight-week aerobic and resistance training on health self-efficacy, body image, and well-being in college students

Chia-Lun LEE [1, 2] *, Ying-Yan LU [3], Zuway-R HONG [4], Nai-Jen CHANG [2, 5]

[1]Center for Physical and Health Education, National Sun Yat-Sen University, Kaohsiung, Taiwan (ROC); [2]Department of Sports Medicine, Kaohsiung Medical University, Kaohsiung, Taiwan (ROC); [3]Center for General Education, Ming Chuan University, Taipei, Taiwan (ROC); [4]School of Medicine, Department of Medical Humanities, Chung Shan Medical University, Taichung, Taiwan (ROC); [5]Precision Sports Medicine and Health Promotion Center, Kaohsiung Medical University, Kaohsiung, Taiwan (ROC)

*Corresponding author: Chia-Lun Lee, Center for Physical and Health Education, National Sun Yat-Sen University, Kaohsiung, Taiwan (ROC).
E-mail: karenlee1129@gmail.com

ABSTRACT

BACKGROUND: This study explored the effects of innovative physical training during COVID-19 periods on college students' health self-efficacy, body image, and subjective well-being.
METHODS: Forty-one students were recruited through convenience sampling and assigned to three exercise groups (*i.e.*, aerobic plus resistance exercise [AE+RE], resistance plus aerobic exercise [RE+AE], and traditional dispersed aerobic plus resistance exercise [control]). The intervention sessions for each group were conducted 3 days per week for 30 min per session. The control group participated in a traditional exercise program comprising 5 days per week.
RESULTS: Study results indicated that all three types of physical training programs effectively improved the participants' health self-efficacy ($P<0.05$). Female students scored significantly higher on health self-efficacy, body image, and subjective well-being than male students ($P<0.05$). The AE+RE group scored significantly higher on body image and subjective well-being than did the other two groups (RE+AE and control, $P<0.05$).
CONCLUSIONS: This study provides valuable insights that can assist in developing innovative physical education courses at higher education institutions to improve body satisfaction and well-being for the college students.

(*Cite this article as*: Lee CL, Lu YY, Hong ZR, Chang NJ. Effects of eight-week aerobic and resistance training on health self-efficacy, body image, and well-being in college students. J Sports Med Phys Fitness 2025;65:583-97. DOI: 10.23736/S0022-4707.24.16237-8)

KEY WORDS: Education; High-intensity interval training; Physical education and training; Mental health.

The American College of Sports Medicine (ACSM) and the World Health Organization (WHO) have indicated that the optimal exercise prescription is 3 days of aerobic exercise and 2 days of resistance exercise per week.[1] If an individual intends to perform both aerobic and resistance exercise on the same day, they should perform resistance exercise before the aerobic exercise. This sequence maximizes its benefits and limits the interference effects of the two forms of training on each other. However, the effects of high-intensity interval training (HIIT) on the health self-efficacy, body image, and subjective well-being of university students remain unclear. The WHO suggested that adults engage in moderate-intensity aerobic exercise for at least 150 min per week or vigorous-intensity exercise for at least 75 min per week.[2] Additionally, aerobic exercise sessions as short as 10 min have been demonstrated to improve cardiovascular fitness.[3] People often struggle to schedule physical activity (PA) because of factors such as work and family obligations. Similarly, college students struggle to meet the exercise intensity and volume requirements outlined in the literature because of their demanding academic and social commitments.[4] Researchers have reported that approximately 40% to 50% of college students are physically inactive. Furthermore, the implementation of health and physical education at the higher education level has failed to effectively increase the PA

level of students.[5] To explore how students can be encouraged to dedicate sufficient time to exercise and be educated on the invaluable health benefits of exercise, the present study investigated how students' exercise needs could be met while optimizing the time efficiency and cost-effectiveness of exercise. Researchers have proposed the concept of concurrent exercise, which integrates aerobic training and resistance training into a single session to achieve both muscle strengthening and cardiovascular enhancement objectives. However, an early study on concurrent training revealed that combining traditional resistance training and traditional aerobic training did not affect cardiovascular function and impeded muscle strength gains.[6] Subsequent research has explored various combinations of aerobic and resistance exercise modalities to understand their effects on physical fitness. Their results have indicated that an effective training regimen involves starting with resistance exercise before engaging in aerobic exercise.[7] This sequence, relative to the inverse sequence, is more likely to yield beneficial adaptations (*e.g.*, muscle gain) while maintaining cardiovascular capacity development and minimizing the interference between the two forms of exercises.[8, 9] However, exercise intensity and volume must also be considered. With the ongoing threat of the COVID-19 pandemic, the public's inclination to engage in physical activities has considerably decreased, resulting in a decline in overall health and quality of life.[10] The psychological health of the public has also been deeply affected by the COVID-19 pandemic. Therefore, the development of an economically efficient exercise regimen has become increasingly crucial. A study revealed college students have positive participation in PA behavior during the COVID-19 pandemic in fostering the development of good mental health, and the influence of positive participation in physical behavior on a student's well-being and quality of life is significant during COVID-19 pandemic.[11] In other words, maintenance of exercise frequency during a COVID-19 pandemic specifically for frequent exercise are recommended to preserve mood states.[12] Therefore, the effects of various innovative physical training methods on the health efficacy, body image, and subjective well-being of college students warrant further exploration and investigation. Studies have explored whether HIIT can replace traditional moderate-intensity continuous training (MICT) and lead to positive outcomes. One study demonstrated that HIIT had positive effects on postexercise enjoyment, affective responses, and social cognition.[13] An early study also noted that HIIT is more ideal than MICT for enhancing self-efficacy.[14] Enjoyment has been identified as a key factor influencing motivational behavior, and it is part of the validated behavior model of most goal achievement theories related to exercise motivation. The greater enjoyment associated with HIIT may be relevant for improving exercise adherence, since running in HIIT model is a low-cost exercise intervention requiring no exercise equipment and similar relative exercise intensities; suggesting that individuals who engage in regular exercise and thus are aerobically fitter, feel a greater sense of challenge, stimulation or accomplishment after training sessions that are perceived to be more demanding.[15] However, various scholars have posited that positive affective responses are related to exercise experience and that the pleasure, liking, and fun generated by exercise can be explained as the enjoyment it brings.[16] Early studies have indicated that self-efficacy can be increased through short bouts (10, 15, and 20 min) of exercise on a treadmill[17] or a 12-week program involving traditional aerobic exercise combined with resistance band training.[18] Individual levels of self-efficacy correlate positively with positive psychological well-being and negatively with fatigue perception.[17] Health self-efficacy, as defined in the present study, is a comprehensive concept that encompasses physical, psychological, and social health dimensions. Happiness can be categorized into two aspects, namely subjective well-being and objective well-being. Subjective well-being is an individual's satisfaction with their overall quality of life,[19] that is, how much they like their current life. In the present study, subjective well-being primarily comprises the four dimensions of life satisfaction, environmental mastery, work engagement, and social contribution. A study on the relationship between the PA and subjective well-being of college students revealed a significant positive correlation (r=0.12–0.64) between these two variables; notably, those who engaged in moderate to high levels of PA tended to exhibit higher levels of subjective well-being relative to those who engaged in low levels of PA.[20] Eloff, O'Neil[21] highlighted the multifaceted role of lecturers (*i.e.*, teachers) in student well-being; this role involves lecturer support, lecturer competence, lecturer availability, interaction, and lecturer attitude. Perceived health self-efficacy has been identified as a major instigating force in the formation of intentions to exercise and the long-term maintenance of exercise habits.[22] College students who engaged in the recommended level of vigorous PA were less likely to report poor mental health and perceived stress relative to those who did not meet this recommendation. Wang, Li[23] administered a questionnaire survey to college students and discovered that physical exer-

cise had a direct positive predictive effect on their subjective well-being; that is, physical exercise increased their life satisfaction and feelings of happiness. Therefore, interventions aiming to improve the mental well-being of college students should also consider promoting PA.[24] However, no study has explored how exercising at a given intensity and volume while varying exercise frequency and manipulating exercise characteristics affects subjective well-being. Studies on body image have indicated that gender and age do not significantly influence changes in body image concern and body image satisfaction; however, participation in exercise can reduce body image concern and improve body image satisfaction for both genders.[25] In a study involving female college students, who were assessed at three time points (*i.e.*, preintervention, postintervention, and 3-month follow-up), body image was reported to be positively correlated with self-esteem and self-efficacy.[26] In that study, the experimental group underwent a body image intervention program comprising a 90-min intervention session conducted every week for 8 weeks. The results of that study indicated that at the end of the intervention, the experimental group achieved improvements in their body image, mindfulness, and self-esteem relative to the comparison and control groups, and these improvements were maintained at the 3-month follow-up. The participants of the aforementioned study were Taiwanese women who had been exposed to both Chinese and Western cultural perceptions of beauty. Numerous participants in the body image program revealed their struggle with societal expectations for 'authentic' or 'ideal' beauty, which limited their ability to freely choose their social roles and norms. Notably, that study explored four dimensions of body image, namely body parts satisfaction, body appearance satisfaction, body image metrics, and body image associated with beauty. However, the literature has not clarified the effects of various types of physical training interventions on the health self-efficacy, body image, and subjective well-being of college students. The aim of the study was to investigate the 8 weeks of innovative physical training on health self-efficacy, body image, and subjective well-being for college students.

Materials and methods

Study design and participants

The study was designed as a randomized parallel trial. Forty-five young college students were recruited from the university's community via advertisements on social media and websites. All participants were sedentary and had no regular exercise experience for at least six months. Eligibility was determined using clinical history and PA. Exclusion criteria were: 1) having physical limitations preventing the performance of exercise (restricting injuries of the musculoskeletal system); 2) having exercise-related dyspnea or respiratory alterations; 3) having exercise-related dyspnea or respiratory alter having chronic heart disease with any worsening the last month; and 4) adhering to less than 85% of the total interventions. After signing a written informed consent form, eligible participants were required to complete a questionnaire before and after completing their assigned 8-week physical training intervention. Participants were randomly assigned to one of three groups as follows: aerobic plus resistance exercise (AE+RE, N.=15]), resistance plus aerobic exercise (RE+AE, N.=15), and traditional dispersed aerobic plus resistance exercise (control, N.=15). However, four participants were excluded during the final analysis due to poor compliance with the exercise protocol. Specifically, the AE+RE and RE+AE groups participated in interventional exercise programs comprising three 30-min sessions per week, whereas the control group participated in a traditional exercise program comprising five sessions per week (3 days of aerobic exercise and 2 days of resistance exercise). The participants (a group of undergraduate students in Taiwan who were enrolled in a physical conditioning course) in all exercise groups were taught to perform a specific format of HIIT. The research conducted herein adhered to the highest standards of ethical practice as outlined by Institutional Review Board-I, Chung-Ho Memorial Hospital under protocol number (KMUHIRB-SV(I)-20200097). Prior to the commencement of the study, all necessary ethical approvals were obtained, ensuring that the research was conducted in full compliance with the prevailing ethical guidelines and regulations. Participants involved in this study provided informed consent after being duly informed of the study's aims, methods, potential benefits, and risks. Their anonymity and confidentiality have been rigorously protected throughout the research process and in the publication of this article.

Maximal heart rate (HR_{max})

Participants completed the health self-efficacy scale, body image scale, and subjective well-being scale, and they were prepared for incremental exercise to exhaustion on an electrically braked cycle ergometer (Load BV, Aveiro, Portugal). To determine the physical capacity of the participants and for medical safety reasons, they were required to perform a conventional clinical symptom-

limited ramp ergometer cycle pretest with heart rate (HR) recordings. The pretest started with cycling at 50 rpm with a workload of 50 watts for 3 min warm-up and increased by 25 watts/min until volitional exhaustion. HR was acquired continuously using telemetry (Polar S810i; Polar Electro Inc., Bethpage, NY, USA), and gas exchange date was acquired every 15 s during exercise using a metabolic device (MetaMax 3B, Cortex Medical, Germany). The HR_{max} was confirmed if two of the following three criteria were met: respiratory exchange ratio >1.10, RPE (rating of perceived exertion 6-20) >19, and HR±10% of age predicted HR_{max}.[27]

Maximal one-repetition (1-RM)

All participants performed the 1-RM test to define the intensity of resistance before the training intervention. After a dynamic warm-up of 8-10 minutes, the participants used the Smith machine to perform a back squat/bench press test at a load of 2×5×40-60% of their 1-RM. After a 2-minute rest, the subjects rechallenged themselves with a load equivalent to 2×2×70% of their 1-RM for the back squat/bench press test. After resting for 1 minute, they attempted 1×1×80% of their 1-RM, then rested for 2 minutes, followed by 1×1×90% of their 1-RM with a 2.5-minute rest, then 1×1×95% of their 1-RM with a 3-minute rest, and finally attempted a maximum repetition at 100% of their 1-RM.

Training intervention

All participants were randomly and evenly assigned to three groups differentiated by exercise training strategy; specifically, the two interventional groups underwent interventional physical training in specific sequences, and the control group participated in a dispersed physical training program. First group: The participants in the AE+RE group performed two sets of aerobic exercises (12 aerobic high-intensity interval movements) followed by a single set of resistance exercises (8 high-intensity resistance movements) three times a week. Each movement was performed for 30 s, with a 15-s rest being implemented between movements, and each set comprised four movements, with a 1-min rest being implemented between sets, resulting in a total training time of 12 min (three sets of exercises for a total of 30 min). Second group: The participants in the RE+AE group performed a single set of resistance exercises followed by two sets of aerobic exercises three times a week. The details pertaining to the exercises are identical to those for the AE+RE group. Third group: The participants in the control group underwent traditional physical training. Specifically, they underwent training 5 days a week (3 days of aerobic exercise and 2 days of resistance exercise). The weekly training duration was 90 min for the two newly developed and innovative forms of physical training (*i.e.*, AE+RE and RE+AE programs) and 90 min for the traditional physical training program. The aerobic exercises were performed at an intensity of 80-85% of an individual's HR_{max} during weeks 1-4 and increased the intensity to 85-90% of an individual's HR_{max} during weeks 5-8. The aerobic exercises included the following: high knee runs, plank punches, jumping jacks, side skaters, fake jump rope, single leg jumps, burpees, Russian twist, split lunges, dumbbell overhead presses, push-ups, and squat jumps. After 1-RM testing, participants performed as many repetitions as possible in a set, with a load equivalent to 40-60% of 1-RM for the lower limb and 10-30% of 1-RM for the upper limb. Adjust resistance training intensity every four weeks as participants advance. Each physical training program was conducted over 8 weeks. The resistance exercise included two sets of back squats, two sets of lying barbell chest presses, two sets of barbell rows, two sets of barbell split lunges, barbell good mornings, barbell biceps curls, triceps curls, and back leg raises. The HR monitors stored all exercise session data to confirm exercise adherence and HR against the logbooks. This information was essential for evaluating the accuracy and consistency of the participants' self-reported exercise habits.

Instrument development and validation

Health self-efficacy scale

A 12-item health self-efficacy scale was employed to measure the health self-efficacy of the participants. The scale items of this questionnaire cover the three domains of physical health, mental health, and social health. The scale's framework is based on the individual psychosocial functioning aspect of social-learning theory.[28] The items are rated on a 5-point scale with endpoints ranging from 1 (very poor) to 5 (very good). An example of an item on the scale is "what do I think about my physical condition prior to exercising?" The health self-efficacy scale was used to assess the participant's feelings after performing various types of exercises. The total score of the scale ranges between 24 and 120. In the present study, the overall scale items demonstrated strong internal consistency with a Cronbach's alpha of 0.90, meeting the criterion suggested by Tavakol *et al.*[29] for good internal consistency (Cronbach's alpha=0.8-0.9).

Body Image Scale (short version)

Body image is an individual's internal representation of their outer appearance.[30] The original body image scale used during the pilot phase of the present study comprised 34 items; however, after item analysis, factor analysis, and internal reliability examination were conducted, only 26 items were retained to achieve Cronbach's alpha of 0.93. The body image scale assesses four dimensions (*i.e.*, body parts satisfaction, body appearance satisfaction, body image metrics, and body image associated with beauty) through questions such as the following: "how satisfied are you currently with each part of your body?," "How satisfied are you with your ability to maintain your physical appearance?," "To what extent do you agree with the definition of beauty?," and "What types of opinions would you consider to determine whether your body image aligns with the established standards? To what extent do you agree with these opinions?"

Subjective Well-Being Scale

The scale for subjective well-being employed in the present study evaluates individuals by considering various dimensions and the relevant factors that can positively or negatively affect human well-being. Subjective well-being is a fundamental aspect of people's lives because it is regarded as an indicator of societal progress.[31] The scale comprises the four main dimensions of life satisfaction (13 items), environment mastery (10 items), work engagement (nine items), and social contribution (four items). In the present study, the Cronbach's alpha of the subjective well-being scale reached 0.96 after 10 items were removed following the pilot phase of the present study.

Statistical analysis

At pretest, all variables were compared between groups using Student's *t*-test. Pairwise *t*-tests were performed to examine the differences between the pretest results (before the exercise intervention) and post-test results (after the exercise intervention). Independent One-way ANOVA was used to examine the differences in HR and exercise adherence between three groups. Analysis of covariate (ANCOVA) was conducted to investigate the differences between the participants in the three groups concerning their post-test scores for participant characteristics, health self-efficacy, body image, and subjective well-being. Bonferonni corrections were also made to guard against making Type I errors. The Eta partial squared was assessed by η^2 obtained from the covariate analysis with small (η^2=0.01), medium (η^2=0.06), and large (η^2=0.14) effects defined according to Lakens.[32] Exploratory factor analysis (EFA) and internal consistency assessments were conducted to examine the structural validity and reliability of the instruments used in the present study. The overall scale had an internal consistency of .898. The Kaiser-Meyer-Olkin (KMO) measure and Bartlett's Test of sphericity revealed a high KMO value (.861) and significant differences for all items (approximate χ^2=1370.375, P<0.001). The EFA results revealed that the final version of the overall scale comprised three factors that collectively accounted for 78.20% of the variance. Data processing and analysis were conducted using the statistical software SPSS 28.0 (IBM, Armonk, Armonk, NY, USA). *A-priori* sample size (ES) calculation based on questionnaire changes in self-perception of health awareness, body image, and well-being as the primary outcome was conducted using G*Power (G-Power, Brunsbüttel, Germany).[33] *A-priori* power analysis was estimated based on data from the published study[34] which compared the training and control groups. The ES in published study was 0.7, considered to be large (ES=0.8) using Cohen's criteria. With a significance criterion of α=0.05 and power = 0.80,[35] the minimum sample size needed with this ES is N.= 15. ES which depicts the magnitudes of effects, was calculated using Cohen's *d*.[36] The ES (*d*) has three relevance: small (*d*=0.2), medium (*d*=0.5), and large (*d*=0.8). The statistical significance level was set at P≤0.05. Data are presented as mean ± standard deviation. The 95% confidence intervals (CI) or 95% CI on the difference between means were also calculated.

Results

The results obtained after 8 weeks of innovative physical training interventions are as follows.

Participant characteristics

Two participants in the AE+RE exercise group ceased attending the class for personal reasons, and two participants in the control group were unavailable for post-testing. Consequently, these participants were excluded from the analysis. This led to the inclusion of data from 13 participants in the AE+RE group, 15 in the RE+AE group, and 13 in the control group for the final analysis. There were no statistically significant differences found when testing homogeneity among the groups (P>0.05), but the waist circumference demonstrated a significant decrease after training in the RE+AE group (*t*=3.36, *d*=0.868, P<0.01). There were no group differences in physical characteristics (Table I).

TABLE I.—*Participants characteristics at pre- and post-test.*

Variables	Pre			Post			*F*	P	η^2
	AE+RE	RE+AE	Control	AE+RE	RE+AE	Control			
BW (kg)	72.9±13.2 (64.9-80.9)	72.4±9.0 (67.3-77.3)	73.8±15 (64.4-83.3)	71.9±11.8 (64.7-79.0)	71.1±8.2 (66.6-75.7)	73.9±15 (63.7-82.5)	0.24	0.78	0.01
BMI (kg/m^2)	25.2±4.6 (22.4-28.0)	25.5±2.0 (24.4-26.7)	26.3±5.4 (23.1-29.6)	25.1±3.6 (23.4-27.8)	25.5±1.7 (24.5-26.5)	26.4±5.2 (23.2-29.6)	0.45	0.64	0.03
Waist circumference (cm)	83.4±10.1 (77.3-89.6)	84.9±6.8 (81.1-88.7)	85.0±13.2 (77.1-93.0)	82.9±9.9 (76.8-88.9)	83.3±7.0* (79.4-87.2)	84.7±12.4 (77.2-92.3)	1.05	0.36	0.06
SBP (mmHg)	113±11 (106-120)	108±11 (103-115)	114±9 (109-120)	112±10 (106-119)	108±7 (103-113)	113±9 (107-119)	0.26	0.77	0.01
DBP (mmHg)	74±8 (69-79)	71±7 (67-74)	73±10 (67-79)	73±7 (68-78)	72±5 (69-75)	73±6 (69-77)	0.05	0.95	0.01

Data are presented as mean±SD (95% CI).
SD: standard deviation; CI: confidence interval; BW: body weight; BMI: Body Mass Index; SBP: systolic blood pressure; DBP: diastolic blood pressure; AE: aerobic exercise; RE: resistance exercise.
*Significant change for pretest within group.

Exercise adherence to the 8-weeks program was similar among AE+RE (98.1%±1.5%), RE+AE (98.2%±1.7%), and control groups (98.0%±1.6) (P>0.05). After 8-weeks training, the highest HR during exercise in the AE+RE, RE+AE, and Control were significant difference (176±9 beats/min, 177±7 beats/ min, and 163±10 beats/min, respectively; 95% CI=158-168 beats/min, F=10.86, P<0.05, η^2=0.364). The *post-hoc* revealed the exercising HR was significantly higher in the AE+RE and RE+AE groups compared with control group (P<0.01). In addition, when comparing RPE after exercise there was a substantial difference between AE+RE (15.2±1.8, 95% CI=14.1~16.3) and control group (13.9±2.0, 95% CI=12.6~15.2) (F=4.6, P<0.01, η^2=0.22); there was no significant difference between RE+AE (16.4±1.4, 95% CI=15.6~17.2) and control group.

Innovative physical training interventions led to improved health self-efficacy, body image, and subjective well-being among participants

For health self-efficacy, the study results indicated that all three types of physical training programs effectively improved the participants' health self-efficacy. For the various dimensions of health self-efficacy, the improvement in the physical health dimension was significant in the AE+RE (t=-1.95, 95% CI difference=-2.96~0.49, P=0.05, d=0.51), RE+AE (t=-2.62, 95% CI difference=-4.3~0.43, P=0.02, d=0.51), and Control (t=-2.51, 95% CI difference=-4.7~-0.34, P=0.02, d=0.65) groups. By contrast, no significant improvements were identified for overall health self-efficacy and the health self-efficacy dimensions of mental health and social health (P>0.05; Figure 1). The body satisfaction dimension of the body image significantly improved in the AE+RE group (t=-2.34, 95% CI difference=-7.27~1.73, P=0.05, d=0.511). Moreover, the overall score for the body image significantly improved in the AE+RE group (t=-1.57, 95% CI difference=-7.48~2.25, P=0.05, d=0.511) and in the RE+AE group (t=-2.40, 95% CI difference=-6.18~0.34, P=0.031, d=0.606). However, there were no significant differences in body appearance satisfaction, body image metrics, and body image associated with beauty between pre- and post-test (Figure 2, 3). For subjective well-being, the results revealed that life satisfaction in the RE+AE group has a significant difference (t=2.171, 95% CI difference=0.027~4.51, P=0.048, d=0.282); but AE+RE (t=-0.05, 95% CI difference=-3.4~3.3, P=0.96, d=0.013) and Control (t=-0.86, 95% CI difference=- 4.32~1.86, P=0.40, d=0.012) were not a significant difference. Relative to life satisfaction, three physical training programs did not significantly improve the participants' overall subjective well-being and other specific dimensions of subjective well-being in environmental mastery, work engagement, and social contribution (P>0.05).

Gender-stratified differences in health self-efficacy, body image, and subjective well-being after 8 weeks of physical training

Gender-stratified changes in the participants' health self-efficacy, body image, and subjective well-being before and after undergoing the physical training programs were analyzed. The t-test results indicated that among the participants who underwent the AE+RE intervention, the female participants significantly outscored their male counterparts for physical health self-efficacy (t=-1.650, 95% CI difference=-.7.2~1.5, P=0.048, d=0.937), overall health

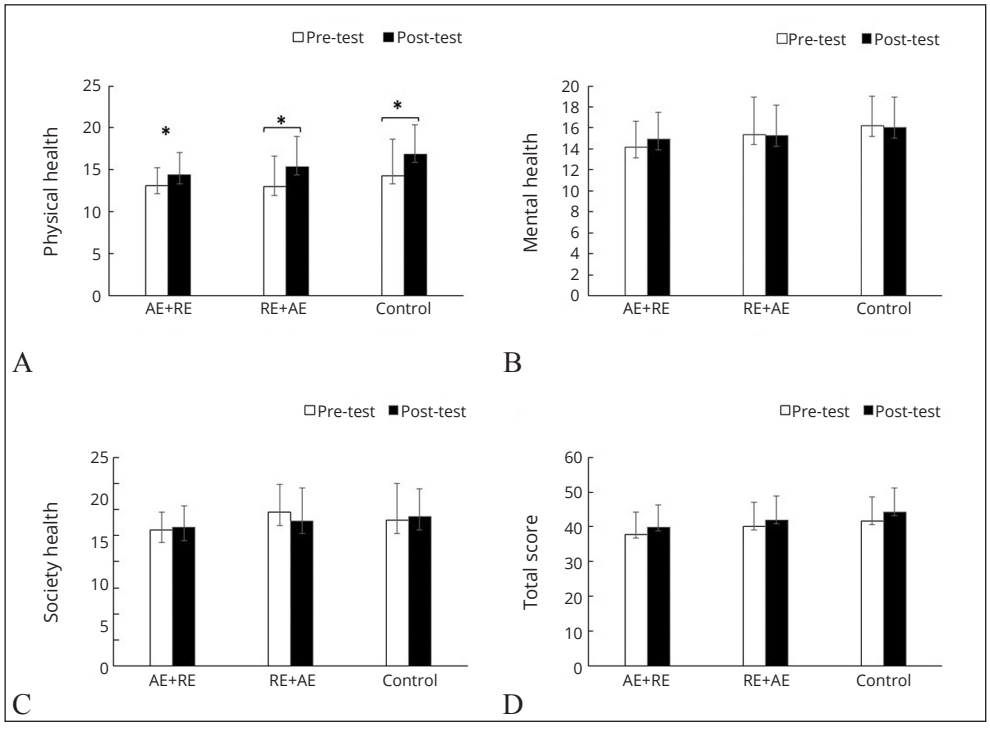

Figure 1.—Physical health (A), mental health (B), society health (C), and total score (D) for health self-efficacy in response to aerobic plus resistance (AE+RE), resistance plus aerobic training (RE+AE) and traditional dispersed aerobic plus resistance exercise (control).
AE: aerobic exercise; RE: resistance exercise.
*Significant difference between pre- and post-test (P<0.05).

self-efficacy (*t*=-1.541, 95% CI difference=-12.4~2.2, P=0.050, *d*=0.853), overall body image (*t*=-1.604, 95% CI difference=-16.6~2.62, P=0.037, *d*=0.892), subjective well-being pertaining to life satisfaction (*t*=-1.823, 95% CI difference=-10.56~1.0, P=0.046,, *d*=1.020), subjective well-being pertaining to environmental mastery (*t*=-5.690, 95% CI difference=-8.8~–3.89, P<0.001, *d*=3.180), and overall subjective well-being (*t*=-2.651, 95% CI difference=-30.98~–2.87, P=0.023, *d*=1.469). Among the participants who underwent the RE+AE intervention, the female participants significantly outscored their male counterparts for body image associated with beauty (*t*=-2.386, 95% CI difference=-2.82~-0.14, P=0.033, *d*=1.252). The above results all had large effect sizes. The results are presented in Figure 4. The analysis of covariance results indicated that the AE+RE intervention was significantly more effective than the traditional physical training program in improving the participants' body appearance satisfaction (*F*=1.419, 95% CI difference=-1.23~0.25, P=0.049, η^2=0.082), body image associated with beauty (*F*=1.493, 95% CI difference=-1.11~0.27, P=0.046, η^2=0.090), and overall body image (*F*=1.515, 95% CI difference=-6.56~1.67, P=0.045, η^2=0.092). Furthermore, the AE+RE intervention was significantly more effective than the RE+AE intervention in improving the participants' overall body image (*F*=1.51, 95% CI difference=-5.93~1.89, P=0.045, η^2=0.092) and overall subjective well-being (*F*=1.986, 95% CI difference=-4.72~3.86, P=0.048, η^2=0.095). The above results all had medium effect sizes. The results are presented in Figure 5.

Discussion

In the present study, we reviewed the literature regarding health self-efficacy, body image, and subjective well-being as well as the relevant dimensions required to conduct meaningful research. With respect to the changes in the dimensions of health self-efficacy, body image, and subjective well-being after 8 weeks of various physical training programs involving traditional training and HIIT combined with aerobic and resistance exercises, our key findings are as follows. First, after undergoing the AE+RE intervention, RE+AE intervention, and traditional physical training program (*i.e.*, dispersed aerobic and resistance exercises), all participants exhibited significantly improved health self-efficacy performance (Figure 1). Both the AE+RE and RE+AE interventions significantly improved the overall body image of the participants; however, the traditional physical training program did not have this effect (Figure 2). Second, across the three groups, female

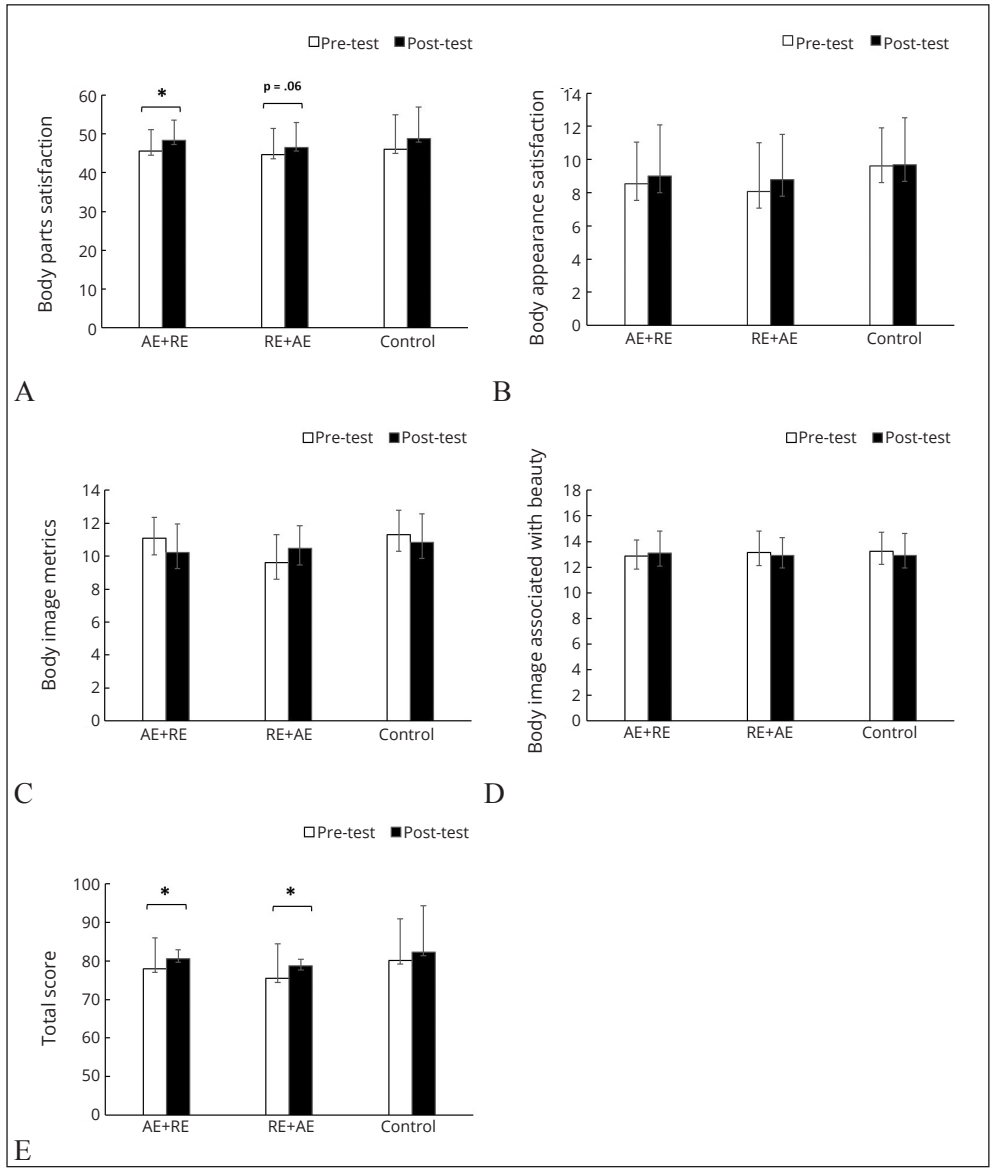

Figure 2.—Body parts satisfaction (A), body appearance satisfaction (B), body image metrics (C), body image associated with beauty (D), and total score (E) for body image in response to different training groups.
*Significant difference between pre- and post-test (P<0.05).

participants significantly outscored their male counterparts for physical health and overall health self-efficacy, overall body image, subjective well-being pertaining to life satisfaction and environment mastery, and overall subjective well-being (Figure 4). However, in the RE+AE group, female college students significantly outscored their male counterparts for body image associated with beauty. Third, the AE+RE group significantly improved in body appearance satisfaction, body image associated with beauty, overall body image, and overall subjective well-being compared to the CON group. Lastly, the waist circumference was significantly decreased after training in the RE+AE group, but there were no significant differences in body weight, BMI, SBP, and DBP among groups. None of the participants were injured during or after the physical training sessions.

Changes in health self-efficacy, body image, and subjective well-being at pre- and post-training

Efficacy is an individual's objective ability to perform a specific behavior, and it can be measured by observing

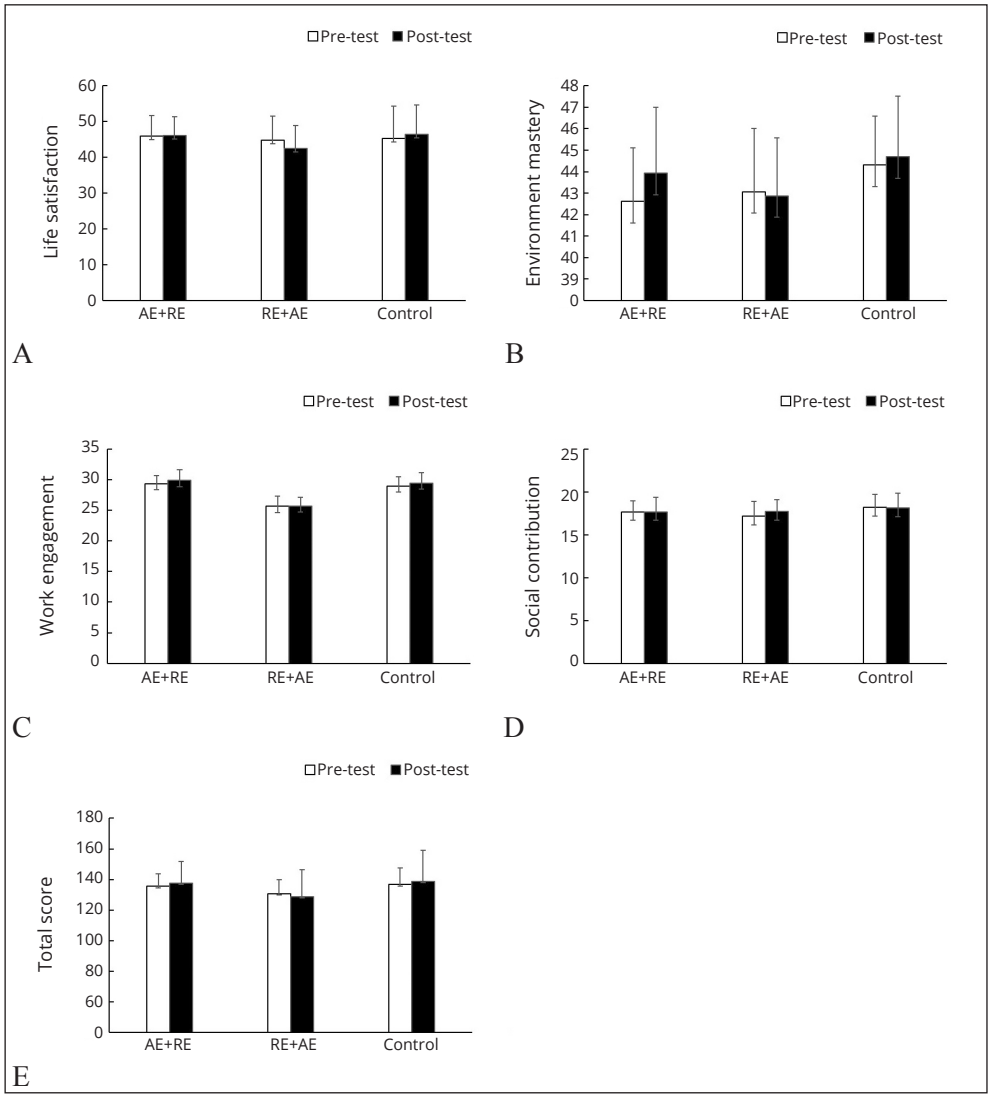

Figure 3.—Life satisfaction (A), environment mastery (B), work engagement (C), social contribution (D), and total score (E) for subjective well-being in response to different training groups.
*Significant difference between pre- and post-test ($P<0.05$).

whether an individual can engage in the behavior.[37] Self-efficacy theory was developed based on the framework of social learning theory, which pertains to the effects of self-referent thought on psychosocial functioning.[28] The relationship between health-related self-efficacy and PA has been extensively studied. A study reported that patients who participated in a moderate exercise regimen (*i.e.*, regular PA) exhibited enhanced self-perceived efficacy in managing their PA.[38] In that study, participants underwent one of three types of 8-week exercise training programs, and all three groups reported significantly improved "physical strength," "muscle strength," "overall physical condition," and "flexibility" after undergoing exercise training. However, the three exercise training programs did not significantly improve "psychological self-efficacy" and "social self-efficacy." Dunn *et al.*[39] asserted that exercise positively affects mental health, including the prevention and treatment of mental disorders. However, various challenges can hinder the implementation of exercise as a treatment in real-world settings. Social self-efficacy is an individual's belief in their ability to engage in social behaviors and interactions successfully. Although exercise has been reported to have positive effects on mental health, few studies have examined its direct effect on social self-efficacy. A study reported that exercise indirectly improves social self-efficacy by reducing anxi-

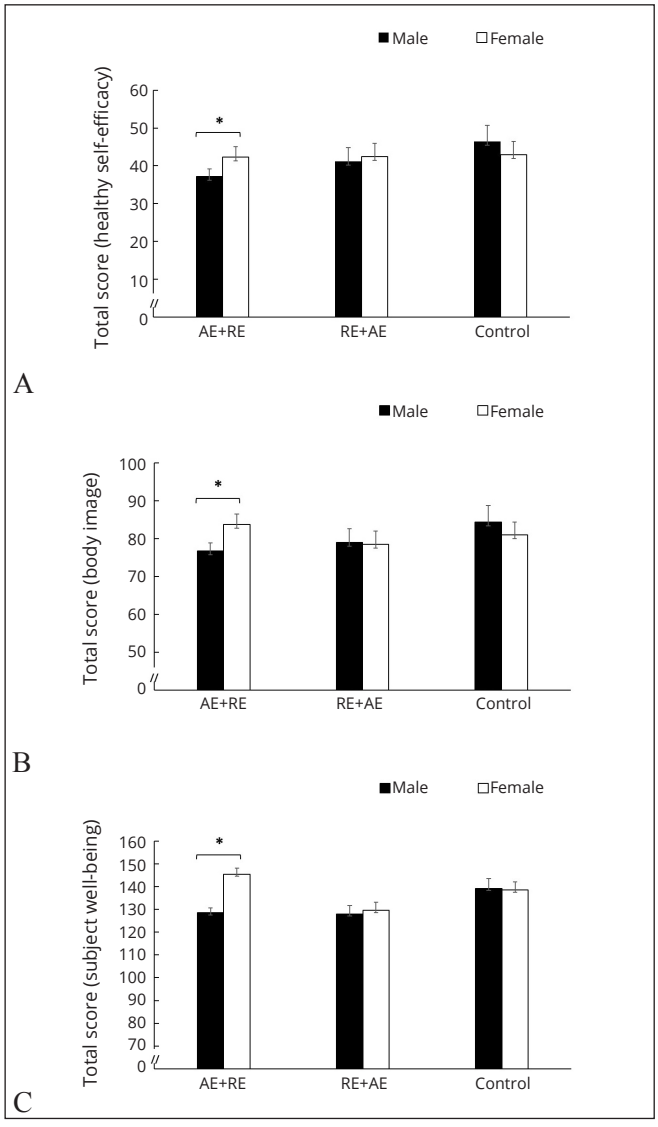

Figure 4.—The overall scores for health self-efficacy (A), body image (B), and subjective well-being (C) were analyzed across different genders in the AE+RE, RE+AE, and control.
AE: aerobic exercise; RE: resistance exercise.
*Significant difference between pre- and post-test (P<0.05).

ety and depression,[40, 41] which can in turn enhance social functioning. Accordingly, exercise training can substantially improve the social and psychological health of college students by reducing their anxiety and depression. Participation in group or team exercise can create opportunities for social interactions and increase social support, contributing to improved social self-efficacy. However, in the present study, all three physical training programs were individual-oriented rather than team- or group-based

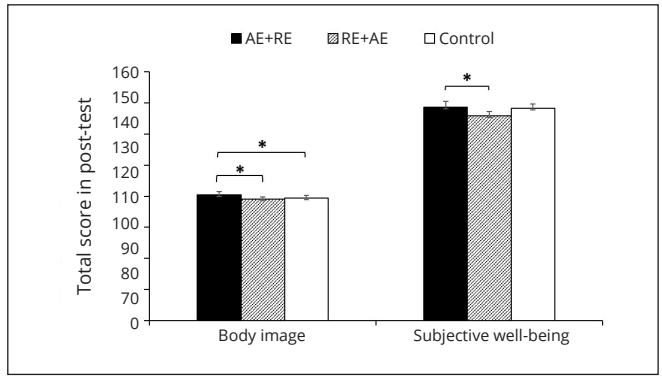

Figure 5.—Total scores for body image and subjective well-being in response to AE+RE, RE+AE, and control following covariance analysis.
AE: aerobic exercise; RE: resistance exercise.
*Significant difference among the groups (P<0.05).

exercise programs. Therefore, their effects on social self-efficacy were nonsignificant. The content and curriculum planning for an exercise training program encompasses course scheduling, teaching methods, instructional strategies, physical and psychological classroom climate,[41] and decisions regarding the implementation of cooperative learning. All these factors can influence psychological and social health. Thus, future studies should investigate the effects of group exercise, individual exercise, and team sports on social self-efficacy, thereby improving the understanding of the relationship between exercise and social functioning. After 8 weeks of AE+RE or RE+AE intervention, the participants in the present study exhibited significant improvements in overall body image; in particular, the AE+RE group showed a significantly higher level of body satisfaction after undergoing training, whereas the improvement experienced by the RE+AE group did not reach significance (P=0.06). Additionally, the expected significant improvements in "body appearance satisfaction," "body image metrics," and "body image associated with beauty" did not manifest. Body image is a complex construct influenced by various factors, including cultural and social norms, personal experiences, and psychological factors.[42, 43] A review paper explored the effects of exercise intervention on body image, and it revealed that exercise duration (average = 49.09 min, range = 20 to 75 min; z=0.75, P=0.45), intervention length (average = 12.7 weeks, range = 4 to 52 weeks; z=-0.004, P=0.99), exercise intensity (moderate *vs*. strenuous; P=0.41), and exercise type (aerobic, resistance, or both) did not moderate effect size; by contrast, weekly exercise frequency (average=2.81 times/week, range=1 to 5, z=-2.50, P=0.01) moderated effect size, indicating

that interventions with a higher weekly frequency exhibited greater effects. The present study revealed a small effect size, indicating that the implemented exercise interventions resulted in the intervention groups experiencing improvements in body image relative to the control group.[44] The findings of the present study generally align with those of Campbell *et al.*; specifically, we discovered that college students who engage in appropriate and frequent exercise interventions can experience improved body image. However, on whether the intensity and mode of exercise are vital factors influencing body image, the present study revealed that focused AE+RE or RE+AE resulted in significantly more improvements in the body image of college students than in control group. The present pioneering study explored the effects of various types of HIIT and traditional HIIT on the participants' body image; however, further research on PA is required to clarify multiple effects. The three 8-week physical training programs did not alter the subjective well-being of the participants in the present study. Shang *et al.*[20] revealed that college students with a positive body image tend to experience favorable subjective well-being, and that self-esteem is a key protective factor for individual well-being. However, in the present study, the direct effects of physical exercise on subjective well-being and its various dimensions all contained zero, indicating that physical exercise did not directly affect subjective well-being. In addition, Jebb *et al.*[45] analyzed the differences in four key predictors of subjective well-being and how their associations were influenced by marriage status, employment status, prosociality, and life meaning. They discovered that only life meaning is strongly and consistently associated with all subjective well-being measures across all regions and ages. In the present study, four dimensions of subjective well-being were examined, namely life satisfaction, environmental mastery, work engagement, and social contribution. The preceding discussion reveals that a critical predictor of subjective well-being is an individual's ability to find happiness by finding meaning in their lives. Although short-term PA interventions may influence body image satisfaction, their effect on individual subjective well-being may be limited. The RE+AE group experienced a notable decrease in waist circumference following the training, likely due to the enhanced fat-burning effect of concurrent exercise.[46] Even though the AE+RE and control groups did not display a decrease in waist circumference, weight management could still be attained through exercise regimens during the period affected by the epidemic.

Differences in health self-efficacy, body image, and subjective well-being stratified by gender

The study's findings revealed that in the AE+RE group (*i.e.*, AE followed by RE), female participants scored significantly higher than male participants by 13.77%, 9.15%, and 13.18% for health self-efficacy, body image, and subjective well-being, respectively. In contrast to the RE+AE group (*i.e.*, RE followed by AE) and the control group (traditional aerobic and resistance exercises), these notable differences were not observed. Several studies have indicated that women tend to exhibit lower health self-efficacy and have a more negative body image relative to men.[47, 48] Attitudes toward body image encompass an individual's self-perceptions, thoughts, emotions, and actions regarding their physical characteristics.[47] A study reported that health self-efficacy is linked to body image; that is, individuals demonstrate respect for their bodies by tending to their needs, adopting health-promoting behaviors, and mentally rejecting cultural messages that endorse unattainable standards for thinness.[48] Exercise is likely to positively influence how women experience their bodies, relieve stress, enjoy themselves, and feel about their health. After participating in a study, women with a stronger pre-existing desire for thinness and weight concerns tended to feel slimmer following exercise intervention.[49] The study involved sedentary individuals with suboptimal health who adhered to a sedentary lifestyle and exhibited at least one unhealthy characteristic, such as high blood pressure, elevated blood lipid levels, and excessive waist circumference or Body Mass Index. This population with suboptimal health showed a greater inclination toward improving their health. Following 8 weeks of exercise training, the female participants demonstrated greater improvements in health self-efficacy, body image, and well-being compared to the male participants. The study also revealed a connection between societal pressures and expectations and the women's appearance and body image. Similarly, women were more likely than men to experience body dissatisfaction and negative body image.[50] These phenomena may be attributed to contemporary societal beauty standards, often unattainable and unrealistic for many women. Furthermore, women may be more prone to changes in dependent variables resulting from undergoing aerobic–resistance exercise programs and women have higher body image associated with beauty score from RE followed by AE program (female *vs*. male=13.63±0.92 *vs*. 12.14±1.46, P=0.03); however, these dependent variables are unaffected by gender when a program involving traditional aerobic

and resistance exercises is implemented. discovered that a 15-week, 2 days-per-week weight training intervention significantly improved muscular strength, emotional well-being, and body image of their female participants. The results here are similar to those of Tucker *et al*.[51] research, indicating that strength training can also improve women's positive perceptions of beauty of body image. Our findings may be related to the frequency and order of exercise or happiness. Research on how the sequence of movements affects body image is scarce, and the discussion in this area may face numerous limitations. Conversely, there's substantial research examining gender differences concerning happiness. Studies that have explored gender differences in subjective well-being have reported inconsistent findings.[52] Although several studies have failed to identify significant gender differences in life satisfaction or happiness, others have reported that depending on the situation, women may exhibit higher subjective well-being levels,[53] quality of life levels,[52] and happiness than men.[54] Blanchflower *et al.*[55] give recent controversies about the existence of a gender well-being gap we revisit the issue estimating gender differences, women report being happier and more satisfied with their lives overall because women might be more open to emotional experiences and may experience both positive and negative emotions more intensely than men. A study by de Vries *et al.*[56] indicated that biological factors, such as hormones, neurotransmitters, inflammatory markers, and genetic distinctions between men and women, can affect the emotional aspects of subjective well-being for both genders. Furthermore, a study demonstrated a positive and significant correlation between the level of physical exercise and the level of subjective well-being across all dimensions.[20] As previously indicated, engaging in resistance exercises before aerobic activities can enhance women's body image associated with beauty scores. This study supports the notion that participating in resistance exercises allows women to boost their body image, which is associated with beauty scores. Nonetheless, the specific impact could differ based on the kind of exercises performed. Collectively, the current results suggest that the psychological effects of physical exercise interventions on women are complex and determined by multiple factors. Future studies should expand on our findings to further the understanding of gender and well-being in the context of physical training interventions. Furthermore, understanding the roles of various biological, individual, and environmental factors on differences in subjective well-being is crucial. Notably, although various factors influence gender differences in subjective well-being, the present study's findings indicate that aerobic exercise followed by resistance exercise can significantly improve women's healthy self-efficacy, body image, and subjective well-being.

Changes in health self-efficacy, body image, and subjective well-being among study groups

The study groups did not differ significantly in their overall health self-efficacy after undergoing 8 weeks of physical training. However, the AE+RE group significantly outscored the RE+AE group for both overall body image and overall subjective well-being. Moreover, the AE+RE program led to greater improvements in body appearance satisfaction and body image associated with beauty relative to the RE+AE program. No differences among the study groups were identified for overall health self-efficacy after 8 weeks of physical training. Hickson[6] asserted that concurrent training can interfere with strength development, particularly when the implemented training involves a high volume of endurance training combined with resistance training. This interference can be attributed to factors such as neuromuscular adaptations, hormonal responses, and muscle damage. However, Hickson[6] suggested that athletes and trainers carefully consider the balance between strength and endurance training to optimize performance outcomes. The present study did not focus on exploring optimal athletic performance for athletes; instead, it focused on determining which exercise combination can optimally improve physical fitness, self-efficacy, body image satisfaction, and subjective well-being among college students. The 8-week concurrent AE+RE training program resulted in significantly greater improvements in body image and subjective well-being compared with the other two training programs. This finding may be attributed to the positive effects of aerobic exercise. A study revealed that female university students who underwent aerobic training experienced greater reductions in social physique anxiety and that those who underwent strength training tended to report greater improvements in appearance evaluation; additionally, perceived aerobic endurance and aerobic self-efficacy were revealed to be significantly associated with body image.[57] A randomized trial compared the effects of aerobic training, resistance training, and combined aerobic–resistance training on the body mass and fat mass of adults with overweight, and it reported that aerobic training was more effective than resistance training in reducing the fat and body mass of sedentary adults; however, resistance training was required to increase their muscle mass and strength.[58] This finding indicates that resistance training can increase strength and muscle mass, whereas

aerobic training can improve cardiovascular fitness and reduce body fat. A potential explanation for this phenomenon is the widely recognized positive effects of exercise on overall mood and emotional states,[59] such as the perception of "feeling fat." That is, aerobic training may cause adults to feel happier and more positive in general, leading to their bodies burning more fat. Notably, the participants who engaged in aerobic plus resistance exercises experienced significantly greater improvements in perceived subjective well-being and body image compared to those who engaged in resistance plus aerobic exercises. These differences may partially explain our finding that aerobic training was nearly twice as effective as resistance training in improving body image associated with beauty and body appearance satisfaction. The subjects of this study underwent eight weeks of training with three different exercise regimes and completed pretests and post-tests.

Limitations of the study

The discussions above can provide us with a deeper understanding of college students' self-perceived health, body image, and well-being. It is possible, however, that the relatively small number of participants may limit the interpretation of the results. Limitations to the extant literature and future directions for research with exercise intervention on gender difference are suggested.

Conclusions

College students who engaged in 3 days a week of aerobic training followed by resistance training, 3 days a week of resistance training followed by aerobic training, or 5 days a week of traditional training all reported significantly enhanced health self-efficacy. However, the innovative physical education training program during the COVID-19 pandemic in which aerobic exercise was followed by resistance training resulted in significantly higher scores for body image and subjective well-being in college students relative to the other two groups. This research's findings could offer insightful direction in the ongoing evolution and investigation of university sports education curricula, even amidst times affected by an epidemic. Confirming the pathway involving physical exercise, health self-efficacy, body image, and subjective well-being provides evidence clarifying the optimal physical education intervention. Accordingly, we recommend implementing high-intensity interval aerobic exercise followed by high-intensity interval resistance exercise for at least 8 weeks. This approach will enhance the overall health-related components, body satisfaction, and well-being of young adults. However, it's important to note that this study's limited sample size (N.=41) may restrict its generalizability, and its findings may be confined to specific ethnic groups because the participants are university students.

References

1. ACSM. ACSM's Guidelines for Exercise Testing and Prescription. Eleventh Edition. Baltimore, MD: Lippincott Williams & Wilkins; 2021.

2. World Health Organization. World Health Organization guidelines on physical activity and sedentary behavior; 2020 [Internet]. Available from: https://www.who.int/publications/i/item/9789240015128 [cited 2024, Nov 19]

3. DeBusk RF, Stenestrand U, Sheehan M, Haskell WL. Training effects of long versus short bouts of exercise in healthy subjects. Am J Cardiol 1990;65:1010–3.

4. Lowry R, Galuska DA, Fulton JE, Wechsler H, Kann L, Collins JL. Physical activity, food choice, and weight management goals and practices among US college students. Am J Prev Med 2000;18:18–27.

5. Keating XD, Guan J, Piñero JC, Bridges DM. A meta-analysis of college students' physical activity behaviors. J Am Coll Health 2005;54:116–25.

6. Hickson RC. Interference of strength development by simultaneously training for strength and endurance. Eur J Appl Physiol Occup Physiol 1980;45:255–63.

7. Tsitkanou S, Spengos K, Stasinaki AN, Zaras N, Bogdanis G, Papadimas G, *et al.* Effects of high-intensity interval cycling performed after resistance training on muscle strength and hypertrophy. Scand J Med Sci Sports 2017;27:1317–27.

8. Bishop DJ, Bartlett J, Fyfe JJ, Lee M. Methodological considerations for concurrent training. In: Schumann M, Rønnestad BR, editors. Concurrent Aerobic and Strength Training. Berlin: Springer; 2019. p.183–96.

9. Delgado-Floody P, Soriano-Maldonado A, Rodríguez-Pérez MA, Latorre-Román PÁ, Martínez-Salazar C, Vargas CA, *et al.* The Effects of Two Different Concurrent Training Configurations on Markers of Metabolic Syndrome and Fitness in Women With Severe/Morbid Obesity: A Randomised Controlled Trial. Front Physiol 2021;12:694798.

10. López-Valenciano A, Suárez-Iglesias D, Sanchez-Lastra MA, Ayán C. Impact of COVID-19 Pandemic on University Students' Physical Activity Levels: An Early Systematic Review. Front Psychol 2021;11:624567.

11. Fang JD, Teng PC, Wang FJ. The Impact of Physical Education Classes on Health and Quality of Life during the COVID-19. Appl Sci (Basel) 2021;11:8813.

12. Kontoangelos K, Economou M, Papageorgiou C. Mental health effects of COVID-19 pandemia: a review of clinical and psychological traits. Psychiatry Investig 2020;17:491–505.

13. Stork MJ, Banfield LE, Gibala MJ, Martin Ginis KA. A scoping review of the psychological responses to interval exercise: is interval exercise a viable alternative to traditional exercise? Health Psychol Rev 2017;11:324–44.

14. Brown DM, Teseo AJ, Bray SR. Effects of autonomous motivational priming on motivation and affective responses towards high-intensity interval training. J Sports Sci 2016;34:1491–9.

15. Bartlett JD, Close GL, MacLaren DP, Gregson W, Drust B, Morton JP. High-intensity interval running is perceived to be more enjoyable than moderate-intensity continuous exercise: implications for exercise adherence. J Sports Sci 2011;29:547–53.

16. McCarthy PJ, Jones MV, Clark-Carter D. Understanding enjoyment in youth sport: A developmental perspective. Psychol Sport Exerc 2008;9:142–56.

17. Rudolph DL, Butki BD. Self-efficacy and affective responses to short bouts of exercise. J Appl Sport Psychol 1998;10:268–80.

18. Jo G, Rossow-Kimball B, Lee Y. Effects of 12-week combined exercise program on self-efficacy, physical activity level, and health related physical fitness of adults with intellectual disability. J Exerc Rehabil 2018;14:175–82.

19. Veenhoven R. Conditions of happiness. Dordrecht: Springer; 2013.

20. Shang Y, Xie HD, Yang SY. The relationship between physical exercise and subjective well-being in college students: the mediating effect of body image and self-esteem. Front Psychol 2021;12:658935.

21. Eloff I, O'Neil S, Kanengoni H. Students' well-being in tertiary environments: insights into the (unrecognised) role of lecturers. Teach High Educ 2023;28:1777–97.

22. Shaw JM, Dzewaltowski DA, McElroy M. Self-Efficacy and Causal Attributions as Mediators of Perceptions of Psychological Momentum. J Sport Exerc Psychol 1992;14.

23. Wang K, Li Y, Zhang T, Luo J. The Relationship among College Students' Physical Exercise, Self-Efficacy, Emotional Intelligence, and Subjective Well-Being. Int J Environ Res Public Health 2022;19:11596.

24. Vankim NA, Nelson TF. Vigorous physical activity, mental health, perceived stress, and socializing among college students. Am J Health Promot 2013;28:7–15.

25. Davis C, Cowles M. Body image and exercise: A study of relationships and comparisons between physically active men and women. Sex Roles 1991;25:33–44.

26. Lee TC, Chiang CH, Chu CL. Body image promotion program with a creative movement approach for female college students in Taiwan. Ment Health Prev 2019;13:107–12.

27. Prieur F, Mucci P. Effect of high-intensity interval training on the profile of muscle deoxygenation heterogeneity during incremental exercise. Eur J Appl Physiol 2013;113:249–57.

28. Bandura A, Walters RH. Social learning theory. Englewood Cliffs, NJ: Prentice-Hall; 1977.

29. Tavakol M, Dennick R. Making sense of Cronbach's alpha. Int J Med Educ 2011;2:53–5.

30. Heinberg LJ, Altabe M, Tantleff-Dunn S, Thompson JK. Exacting beauty: Theory, assessment, and treatment of body image disturbance. Washington, WA: American Psychological Association; 1999.

31. Wish NB. Are we really measuring the quality of life? Well-being has subjective dimensions, as well as objective ones. Am J Econ Sociol 1986;45:93–100.

32. Lakens D. Calculating and reporting effect sizes to facilitate cumulative science: a practical primer for t-tests and ANOVAs. Front Psychol 2013;4:863.

33. Faul F, Erdfelder E, Lang AG, Buchner A. G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behav Res Methods 2007;39:175–91.

34. Wu MY. Effects of high-intensity interval training and resistance training on self-perception of health awareness, body image, well-being, and learning effect of physical education in sedentary college students. Nation Soc Phys Educ 2021;54:327–48.

35. Kang H. Sample size determination and power analysis using the G*Power software. J Educ Eval Health Prof 2021;18:17.

36. Cohen J. A power primer. Psychol Bull 1992;112:155–9.

37. Lawrance L, McLeroy KR. Self-efficacy and health education. J Sch Health 1986;56:317–21.

38. Ewart CK. Role of physical self-efficacy in recovery from heart attack, in Self-Efficacy. Milton Park: Taylor & Francis; 2014. p.287–304.

39. Dunn AL, Jewell JS. The effect of exercise on mental health. Curr Sports Med Rep 2010;9:202–7.

40. Rethorst CD. Effects of exercise on depression and other mental disorders, in APA handbook of sport and exercise psychology, volume 2. Washington, DC: American Psychological Association; 2019. p.109–21.

41. Hong FY, Chiu SI, Chiu SL, Huang DH. Correlations Among Classroom Emotional Climate, Social Self-Efficacy, and Psychological Health of University Students in Taiwan. Educ Urban Soc 2021;53:446–68.

42. Hausenblas HA, Fallon EA. Exercise and body image: A meta-analysis. Psychol Health 2006;21:33–47.

43. Tiggemann M, Williamson S. The effect of exercise on body satisfaction and self-esteem as a function of gender and age. Sex Roles 2000;43:119–27.

44. Campbell A, Hausenblas HA. Effects of exercise interventions on body image: a meta-analysis. J Health Psychol 2009;14:780–93.

45. Jebb AT, Morrison M, Tay L, Diener E. Subjective Well-Being Around the World: Trends and Predictors Across the Life Span. Psychol Sci 2020;31:293–305.

46. Moro T, Marcolin G, Bianco A, Bolzetta F, Berton L, Sergi G, *et al.* Effects of 6 Weeks of Traditional Resistance Training or High Intensity Interval Resistance Training on Body Composition, Aerobic Power and Strength in Healthy Young Subjects: A Randomized Parallel Trial. Int J Environ Res Public Health 2020;17:4093.

47. Cash TF, Henry PE. Women's body images: the results of a national survey in the USA. Sex Roles 1995;33:19–28.

48. Homan KJ, Tylka TL. Appearance-based exercise motivation moderates the relationship between exercise frequency and positive body image. Body Image 2014;11:101–8.

49. Vocks S, Hechler T, Rohrig S, Legenbauer T. Effects of a physical exercise session on state body image: the influence of pre-experimental body dissatisfaction and concerns about weight and shape. Psychol Health 2009;24:713–28.

50. Tylka TL, Sabik NJ. Integrating social comparison theory and self-esteem within objectification theory to predict women's disordered eating. Sex Roles 2010;63:18–31.

51. Tucker LA, Maxwell K. Effects of weight training on the emotional well-being and body image of females: predictors of greatest benefit. Am J Health Promot 1992;6:338–44, 371.

52. Craft BB, Carroll HA, Lustyk MK. Gender Differences in Exercise Habits and Quality of Life Reports: Assessing the Moderating Effects of Reasons for Exercise. Int J Lib Arts Soc Sci 2014;2:65–76.

53. Batz C, Tay L. Gender differences in subjective well-being. Handbook of well-being. Salt Lake City, UT: DEF Publishers; 2018.

54. Arrosa ML, Gandelman N. Happiness Decomposition: female Optimism. J Happ Stud 2016;17:731–56.

55. Blanchflower D, Bryson A. The Gender Well-Being Gap. Soc Indic Res 2024;173:1–45.

56. de Vries LP, van de Weijer MP, Bartels M. The human physiology of well-being: A systematic review on the association between neurotransmitters, hormones, inflammatory markers, the microbiome and well-being. Neurosci Biobehav Rev 2022;139:104733.

57. Martin Ginis KA, Strong HA, Arent SM, Bray SR, Bassett-Gunter RL. The effects of aerobic- versus strength-training on body image among young women with pre-existing body image concerns. Body Image 2014;11:219–27.

58. Willis LH, Slentz CA, Bateman LA, Shields AT, Piner LW, Bales CW, *et al.* Effects of aerobic and/or resistance training on body mass and fat mass in overweight or obese adults. J Appl Physiol 2012;113:1831–7.

59. Ekkekakis P. Pleasure from the exercising body: Two centuries of changing outlooks in psychological thought, in Routledge handbook of physical activity and mental health. London: Routledge; 2023. p.35–56.

Conflicts of interest

The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

Funding
This work was funded by the National Science and Technology Council (MOST 110-2410-H-110-070-MY2 and NSTC 112-2410-H-110 -059 -MY2).

Authors' contributions
Chia-Lun Lee has given substantial contributions to the study conception and design, and to the data collection; Chia-Lun Lee and Ying-Yan Lu contributed to the collection, analysis and interpretation; all authors equally contributed to the manuscript draft and critical revision for important intellectual content. All authors read and approved the final version of the manuscript.

Acknowledgements
The authors acknowledge the teaching assistants who provided experimental testing and helped with various aspects of the project. The authors also acknowledge the participants for their contribution to this work.

History
Article first published online: January 9, 2025. - Manuscript accepted: November 13, 2024. - Manuscript revised: October 31, 2024. - Manuscript received: April 23, 2024.