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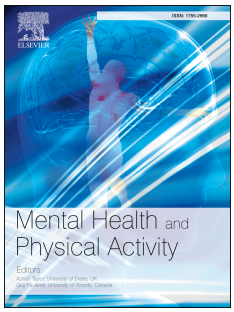

Tendency to avoid physical activity mediates the association between perceived weight stigma and physical activity levels among university students

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Tendency to avoid physical activity mediates the association between perceived weight stigma and physical activity levels among university students

Short title: Perceived weight stigma and physical activity avoidance

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Declaration of interest

All authors declare no conflict of interest.

Author contributions

Conceptualization, JY, I-HC, I-CL, H-PC, P-CH, C-YL; Data curation, JY, I-HC; Formal analysis, J-Y, I-HC, H-PC, J-SC; Funding acquisition, I-HC, I-CL, H-PC, C-YL; Investigation, I-HC, C-YL; Methodology, P-CH, KSO, MDG, C-YL; Project administration, I-CL, C-YL; Resources, JY, I-CL, H-PC, J-SC, C-YL; Software, I-HC; Supervision, P-CH, KSO, MDG, C-YL; Validation, JY, I-CL, H-PC, J-SC; Visualization, I-HC; Roles/Writing - original draft, JY, I-HC, I-CL, P-CH; Writing - review & editing, H-PC, J-SC, KSO, MDG, C-YL.

Ethical statement

The study protocol was approved by the Institutional Review Board of Jiangxi Psychological

Consultant Association (IRB ref: JXSXL-2021-J99). The study complied with the Declaration of Helsinki. Inform consent was obtained from each participant before the study began.

Data sharing statement

The data that support the findings of the present study are available from the corresponding author upon reasonable request.

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Tendency to avoid physical activity mediates the association between perceived weight stigma and physical activity levels among university students

Short title: Perceived weight stigma and physical activity avoidance

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Abstract

Background and Aims: The World Health Organization recently announced an action plan to increase global physical activity (PA) levels due to individuals' increasingly inactive lifestyle. Perceived weight stigma (PWS) is a psychosocial factor that may reduce individuals' PA, and PA avoidance may be involved in this association. Therefore, the present study conducted a cross-sectional design to investigate the mediating effect of tendency to avoid PA in the association between PWS and PA among Chinese university physical education (PE) students and non-PE students.

Methods: Responses from non-PE (n=2877) and PE (n=2286) students were collected via the online survey comprising the Perceived Weight Stigma Scale, Tendency to Avoid Physical Activity and Sport Scale, and International Physical Activity Questionnaire Short Form.

Results: Results of moderated atemporal mediation analysis showed a significant association between PWS and PA mediated by tendency to avoid PA among the two groups (B[SE]=0.94[0.08], $p < .001$). In addition, compared to non-PE students, PE students were significantly less affected by tendency to avoid PA (B[SE]=-2.61[0.29], $p < .001$). However, when affected, PE students showed a larger reduction in moderate PA levels than non-PE students (B[SE]= -9.14[4.51], $p = .043$).

Conclusion: The present study's findings showed that PWS negatively affected PA via the atemporal mediation of tendency to avoid PA among university PE and non-PE students. Additionally, compared to non-PE students PE students showed a larger reduction in moderate PA levels when affected by the tendency to avoid PA. Strategies aimed at reducing weight stigma or promoting PA enjoyment could be adopted to facilitate PA engagement and maintain a physically active lifestyle.

Keywords: weight stigma, physical activity, avoidance, physical education, Tendency to Avoid Physical Activity and Sport Scale (TAPAS)

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Introduction

It is accepted worldwide that physical activity (PA) has physiological and psychological advantages that benefit individuals in maintaining a healthy life (World Health Organization, 2022b). Physiologically, PA has well-known effects in reducing cardiovascular risk, metabolic syndrome, and all-cause mortality rate (Ahmed et al., 2012). Psychologically, PA can reduce psychological distress (e.g., depression and anxiety), enhance the individuals' self-esteem, and maintain good mental well-being (Liu et al., 2015). PA is classified into three levels: light (0 to 2.9 metabolic equivalent of tasks [METs]), moderate (3 to 5.9 METs), and vigorous (more than 6 METs), according to current guidelines (Piercy et al., 2018).

Each level of PA presents with different beneficial effects and clinical implications (Piercy et al., 2018). However, the WHO reported that more than 80% of adolescents and 27% of adults do not meet the WHO's recommended PA levels (World Health Organization, 2022a), and the outbreak of the coronavirus disease 2019 (COVID-19) has had an additional influence on PA reduction (Lopez-Valenciano et al., 2020; World Health Organization, 2022a). Reduced PA may not only cause physiological diseases (e.g., diabetes) (Diabetes Canada Clinical Practice Guidelines Expert Committee et al., 2018) and have psychological impacts (e.g., depression, anxiety) (Fox, 1999), but can result in both financial and medical burden on societal health systems (World Health Organization, 2022a). Therefore, it is of the utmost importance to investigate the mechanisms and factors that may affect individuals' PA levels.

Among the mechanisms explaining PA engagement, two of the four fat stigma mechanisms proposed by Brewis (2014) can serve as the theoretical foundation to investigate the PA engagement. 'Fat stigma', also known as 'weight stigma', is a social devaluation targeted at individuals who are overweight/obese (Bevan et al., 2021; Brewis, 2014). The first fat stigma mechanism proposed by Brewis (2014) indicated that weight stigma in any form can affect behavioral change, including the reduction of PA engagement, because individuals experiencing weight stigma want to avoid what other people think about them. Consequently, individuals experiencing weight stigma tend to reduce

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PA engagement as a way to avoid public stigma (Pearl et al., 2015; Puhl et al., 2020). The second fat stigma mechanism states that weight stigma in any form can lead to psychological distress because weight stigma is a stressor leading to negative emotional reactions. Consequently, weight stigma may increase the psychological burden such as psychological distress (i.e., depression, anxiety) and poorer quality of life (Huang et al., 2022b; Lin et al., 2023; Sutin et al., 2021; Wang et al., 2020). The theoretical framework of the present study is based on these two fat stigma mechanisms. More specifically, it is proposed that perceived weight stigma (PWS), the external devaluation by individuals who perceive themselves as having a weight issue (Huang et al., 2022b), could be an initial trigger causing individuals to have psychological distress to avoid PA engagement which subsequently leads to an actual reduction in PA (Hunger et al., 2015). Given that a recent concept regarding tendency to avoid PA has been developed to link the relationship between PWS and PA (Ajibewa et al., 2022; Bevan et al., 2022; Bevan et al., 2021), the aforementioned theoretical framework can be empirically investigated.

In the aforementioned theoretical framework, PWS is defined as the external devaluation by individuals who perceive themselves as having a weight issue (Huang et al., 2022a) and has been reported to be a psychosocial factor (Chirawat et al., 2022; Nadhiroh et al., 2022) that prevents individuals from participating in PA (Bevan et al., 2021; Vartanian et al., 2018). Speculatively, stigmatized individuals may consider avoidance as a self-protective strategy which helps them escape from psychological stress (Hunger et al., 2015) derived from the harsh comments and judgement of others (Myre et al., 2021), directly resulting in their avoidance of engaging in PA (Brewis, 2014) and the consequential reduction of PA. However, the involvement of tendency to avoid PA in the association between PWS and PA, along with its influences on different levels of PA, remains unclear.

Every PE student in China has one or more exercise specialties. Additionally, they are required to complete PE-related courses including education science, sport science, psychology, and administration. In other words, the Chinese students who majored in PE know the concepts, mechanisms and benefits of PA very well, and are more likely to engage in exercise and sport

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compared to non-PE students given the area they have chosen to specialize in academically. It has been reported that students who major in physical education (i.e., PE students) have higher PA levels than those who major in general subjects (i.e., non-PE students) (Chung, 2003; Gorospe & Ferrer, 2022), because they spend more time engaging in PA and sport training (Chung, 2003). Moreover, the common barriers of PA, such as lack of motivation, equipment, time, and support (Kelly et al., 2016), are rarely reported among PE students. Therefore, it was expected that they would less likely be affected by weight stigmatization as well as have a lower tendency to avoid PA compared to non-PE students. Previous research in China has investigated the effects of weight stigma and its associations with PA (Fung et al., 2019), nomophobia (fear of being without a smartphone) (Liu et al., 2022), food addiction (Cheng et al., 2018; Lin et al., 2020; Wang et al., 2020), sleep (Wang et al., 2021), and quality of life (Fan et al., 2021; Kamolthip et al., 2021). More specifically, the findings indicated that weight-related self-stigma significantly explained the level of PA (Fung et al., 2021) and mediated the association between PA and quality of life (Fan et al., 2021; Kamolthip et al., 2021). In addition, greater weight-related self-stigma was associated with higher PA levels and greater nomophobia (Liu et al., 2022). Moreover, studies have also shown that PWS was associated with inappropriate eating behavior among both individuals who were overweight or non-overweight (Cheng et al., 2018; Lin et al., 2020; Wang et al., 2020), and may increase the individuals' stress and depressive symptoms, which were associated with poorer sleep quality (Wang et al., 2021). However, the issue of weight stigma together with the of tendency to avoid PA and PA among PE students has not yet been investigated. Additionally, the differences between PE and non-PE students in weight stigma, PA avoidance, and PA have never been previously studied.

The contemporary aesthetic that "thin is beauty" in Westernized societies conflicts with the perspective of traditional Asian society that being 'plump' represents being prosperous and wealthy (Cheng et al., 2018). Some more recent literature suggests that Chinese people appear to have become more Westernized and adhere to the "thin is beauty" concept (Lin et al., 2019). In addition, one study reported that Easterners are more self-critical than Westerners because they care more about harmony

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in their society and want to look like their peers (Lo et al., 2011). These cultural differences and similarities may cause some individuals to suffer from weight stigmatization leading to more detrimental consequences (such as eating disorders which have been associated with weight bias and PWS among Hong Kong university students) (Cheng et al., 2018).

Therefore, the present study investigated the associations between PWS and different levels of PA with the involvement of tendency to avoid PA among university non-PE students and PE students in China. PA was classified into four categories: the total activity, moderate MET-minutes per week, vigorous MET-minutes per week, and walking MET-minutes per week. It was hypothesized that (i) PWS would be associated with PA via the tendency to avoid PA; (ii) PE students would be less affected by tendency to avoid PA than non-PE students; and (iii) each PA level among PE students would be less affected by tendency to avoid PA than among non-PE students.

Methods

Participants and data collection

The present study conducted a cross-sectional design and employed convenience sampling to collect data in two different populations: university students majoring in general subjects (i.e., non-PE students) and university students majoring in physical education (i.e., PE students). The inclusion criteria for eligible participants were: (i) being enrolled at a university in mainland China (majoring in any program except for physical education for non-PE students; majoring in physical education for PE students); (ii) reporting a body mass index (BMI) ranging between 14 and 50; and (iii) providing electronic informed consent prior to participate in the study. Data collection was conducted between mid-August, 2022 and end of February, 2023. Faculty members from PE or non-PE departments at universities across mainland China were contacted by the present authors for participant recruitment. To ensure the data quality, a number of specific strategies were employed. Initially, faculty members were responsible for distributing the survey QR codes and giving in-person briefings to the students, urging them to provide honest answers and emphasizing the participant anonymity and data

confidentiality. These faculty members assured the students about the confidentiality of their responses and emphasized that there would be no negative repercussions as a consequence of their responses. These measures were taken to encourage openness and truthfulness among potential participants. Moreover, students had the opportunity to seek clarifications for any questions they found unclear. Secondly, a response analysis was carried out using a time-based filtering criterion. Considering the number of questions in the survey, responses that were completed in less than five minutes were excluded on the premise that brief response times were unlikely to yield thorough and thoughtful answers. The survey was conducted on a voluntary basis, and participants did not receive any form of compensation. The study complied with the Declaration of Helsinki. Inform consent was obtained from each participant before the study began. The Institutional Review Board of **BLIND FOR REVIEW** approved the study protocol.

Seven participants were excluded due to unmet BMI criteria, and 340 were excluded due to response times being too quick in completing the survey. After filtering out participants not meeting the inclusion criteria and those with excessively brief response times in completing the survey, a total of 2,877 non-PE students (excluding those majoring in sports-related fields) were recruited from 19 universities across 13 provinces in mainland China, with an average age of 19.65 years (SD=1.61) comprising more females (n=1722, 56.8%). Additionally, 2,286 PE students were recruited from 42 universities across 15 Chinese provinces in mainland China, with an average age of 21.30 years (SD=2.87) comprising more males (n=1462, 60.7%). More specifically, the prevalence of being overweight was significantly higher among non-PE students from Shanghai (a coastal province in eastern China) and Shanxi (an inland province in northwest China) as well as PE students from Shandong Province in the north China and Henan Province in central China (p = .011). In addition, the prevalence of being overweight was significantly lower among non-PE participants from Qinghai Province in northwestern China, as well as PE students from Jiangxi Province in central China (p = .011). Regarding the PA level, only non-PE students from Sichuan Province in the southwest China had a significantly lower total PA level compared to their counterparts from Shandong Province in

the north China, Qinghai Province in the northwest China, and Hunan Province in the central China ($p < .001$). No significant difference of PA level was found among PE students across provinces.

Measures

Personal background information was collected including the students' major subject, academic year, health status, marital status, height, and weight. Additionally, the online survey included research instruments employed to assess the key study variables. These are detailed below.

The Chinese version of the Perceived Weight Stigma Scale (PWSS) was employed to assess students' experiences of PWS. Adapted from the scale by (Schafer & Ferraro, 2011), the PWSS consists of 10 questions that concern students' encounters with weight-based discrimination in various school and daily life settings. Responses are scored using a binary system: "Yes (1)" or "No (0)" (Chirawat et al., 2022; Gan et al., 2022; Nadhiroh et al., 2022). Example items from the PWSS include "*Due to your weight, you receive less respect compared to others*" and "*Because of your weight, you are treated more rudely compared to others*". The sum of the ten items serves as an indicator of PWS. The Chinese PWSS has demonstrated strong construct validity, as evidenced by high correlations with other PWS scales (Pakpour et al., 2019). Moreover, it has exhibited satisfactory criterion validity through significant correlations with psychological distress (Fung et al., 2021; Huang et al., 2022b). In the present study, the McDonald Omega coefficient (ω) for the entire sample and non-PE students was .87, while it was .89 for PE students.

The Tendency to Avoid Physical Activity and Sport Scale (TAPAS) was used to assess the extent to which students avoid participating in physical activities and sports due to weight or appearance reasons. The TAPAS was developed by (Bevan et al., 2022) and was recently translated into Chinese by (Fan et al., 2023a, 2023b; Saffari et al., 2023). Both the English and Chinese versions of TAPAS have exhibited strong psychometric qualities, including factorial validity, criterion validity, and internal reliability (Bevan et al., 2022; Saffari et al., 2023). The TAPAS comprises 10 items, utilizing a five-point Likert scale that ranges from 1 (*strongly disagree*) to 5 (*strongly agree*). A higher score indicates a greater tendency to avoid PA and sport. A sample item of the TAPAS is *"I am concerned*

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about what other people think of my appearance when I participate in sport". In the present study, the TAPAS demonstrated excellent internal consistency reliability. The McDonald's Omega coefficient (ω) was .96 across three distinct samples: the entire sample, non-PE students, and PE students.

The International Physical Activity Questionnaire Short Form (IPAQ-SF) consists of seven questions designed to assess an individual's engagement in physical activities. Each question probes the duration of a person's involvement in either PA or inactivity (Huang et al., 2022a). The days dedicated to each activity is then converted into a Metabolic Equivalent of Task (MET) value with the truncation of 180 minutes/day as suggested in the guidelines (IPAQ Research Committee, 2005). More specifically, MET values are assigned as follows: 3.3 for walking, 4 for moderate activities like jogging, and 8 for vigorous activities such as swimming. The MET value is subsequently multiplied by the activity's duration to compute different kinds of MET-minutes. The psychometric properties (such as content validity, test-retest reliability and internal consistency) of Chinese IPAQ-SF have been found to be statistically robust in previous studies (Cheng et al., 2019; Fung et al., 2019; Macfarlane et al., 2007; Saffari et al., 2022).

Statistical analysis

The study initially compared PE students and non-PE students on a range of demographic variables, utilizing independent *t*-tests and chi-square tests. Subsequently, descriptive statistics and independent *t*-tests were employed to compare these two student groups concerning weight stigma, the tendency to avoid participating in physical activities or sports, and their engagement in physical activities. Additionally, Pearson correlations were calculated for each group. Finally, a moderated atemporal mediation analysis (Winer et al., 2016) was conducted, adopting a dummy variable where non-PE students were coded as 0 (reference group) and PE students as 1. This analysis aimed to examine the indirect correlation of PWS on PA through the tendency to avoid engaging in PA. PA was categorized into four levels, encompassing total activity, vigorous, moderate, and walking MET-minutes. In consideration of the multiple statistical tests conducted, a Bonferroni correction was

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employed to adjust for Type I error. More specifically, for comparisons involving demographic variables between the two groups, the significance level was adjusted to .006 (.05 divided by nine tests). For comparisons related to variables of interest, the adjusted significance level was set at .008 (.05 divided by six tests). Additionally, in the analysis of Pearson correlations, the significance threshold was adjusted to .002 (.05 divided by 21 tests). These corrections provided stringent control over false positives due to multiple testing.

In the analysis, PROCESS Macro (Model 59) was employed, utilizing 5,000 bootstrap resamples to robustly estimate the model coefficients. This approach allowed the generation of confidence intervals for the coefficients within the model based on percentile bootstrapping. Importantly, the analysis did not perform corrections for multiple testing in this context because of the nature of bootstrap resampling, which primarily focused on estimating confidence intervals rather than conducting multiple independent hypothesis tests. As a result, the traditional concerns regarding the family-wise error rate, which are typically addressed through multiple testing corrections, were considered less relevant in this scenario.

Furthermore, in this model, the study meticulously controlled for potential confounding variables. Key demographic and health-related variables (i.e., sex, health status, age, and BMI) were incorporated as covariates. The inclusion of these variables was critical to minimize confounding effects, thereby ensuring that the observed relationships between the mediator and the dependent variable were not unduly influenced by these factors. By controlling for these covariates, the validity of the findings was enhanced, providing a more accurate representation of the underlying dynamics in the moderated atemporal mediation analysis. All the data analysis were performed using SPSS 22.0 (IBM Corp., Armonk, NY) and the significance level was set at *p*-value lower than .05.

Results

Table 1 presents a comparison of the demographic variables between non-PE students and PE students. By applying the Bonferroni correction to adjust for Type I errors, the results showed

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significant differences in the proportions of sex (non-PE and PE students = 57.6% and 40.3%, $p < .001$), school category (non-PE and PE students = 70.7% and 98.0%, $p < .001$), grade (non-PE and PE students = 28.1% and 32.4% for freshman; 38.3% and 20.1% for sophomore; 11.8% and 25.3% for junior and 0.6% and 10.7% for graduate student, $p < .001$), marital status (non-PE and PE students = 98.3% and 97.3%, $p < .001$), and health status (non-PE and PE students = 9.7% and 5.1%, $p = .002$) between the samples of non-PE students and PE students. Additionally, the height and weight of PE students were significantly higher than those of non-PE students (t[5161] = 26.87 and 8.58 respectively, both $p < .001$). However, there was no significant difference in BMI between the two groups. When stratifying BMI scores, the proportion of overweight individuals was significantly higher among PE students compared to non-PE students (non-PE and PE students = 35.4% and 35.6%, $p = .002$). Notably, when comparing PWS across different weight status (i.e., underweight, normal weight, overweight, and obesity) among both non-PE and PE students, it was found that only one pair comparison showed a statistically significant difference. This significant difference was observed between individuals with obesity and those who were underweight, indicating that the former group experienced notably higher levels of PWS, as shown in the Supplementary Materials (S1).

(Insert Table 1 here)

Table 2 presents the means and standard deviations (SDs) of the variables, as well as their Pearson correlations, for the two samples. Using the Bonferroni correction to examine the mean differences in variables of interest between non-PE students and PE students, the results showed that non-PE students experienced significantly higher PWS and were more inclined to avoid physical activities and sports (t[5161] = 7.59 and 16.87 respectively, both $p < .001$). Conversely, PE students displayed notably higher levels of total activity, vigorous, and moderate MET-minutes when compared to non-PE students (t[5161] = 6.53 [$p < 0.001$], 3.83 [$p < 0.001$], and 3.09 [$p = 0.002$]). However, they exhibited lower but not significant walking MET-minutes compared to their general university counterparts (t[5161] = 2.08, $p = 0.038$). Significant correlations among these variables were observed in both non-PE and PE students.

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Higher PWS was associated with a greater tendency for individuals to avoid participating in PA (r[2875] = .235 in non-PE students and r[2284] = .200 in PE students). Weight stigma was significantly and negatively correlated with individuals' total activity, vigorous and walking MET-minutes per week among non-PE students (|r|[2875] ranged from .078 to .105, $p < .001$) and only correlated to walking MET-minutes per week among non-PE students (|r|[2875] =.080, $p < .001$). Furthermore, a stronger tendency to avoid PA and sports correlated with lower PA levels (|r|[2875] ranged from .096 to .148 for non-PE students and |r|[2875] ranged from .123 to .172 for PE students). The correlations between these variables were higher than that between weight stigma and the group of PA variables although all of these associations had small effect sizes (i.e., absolute values of Pearson's r at .1 or below). More specifically, among non-PE students, the correlation between the tendency to avoid PA and moderate MET-minutes was significantly stronger than the correlation between weight stigma and moderate MET-minutes ($z = 2.41$, $p = .016$). Furthermore, among PE students, the correlation between the tendency to avoid PA with total activity, vigorous, moderate, and walking MET- minutes demonstrated a notably more robust relationship than the correlation between weight stigma and these respective variables (z of total activity, vigorous, moderate, and walking MET- minutes was 2.69 [$p = .007$], 3.93 [$p < .001$], 3.72 [$p < .001$], and 2.43 [$p = .015$], respectively).

Table 3 summarizes the indirect effects of weight stigma on total activity and METs for various activities through the tendency of avoiding engaging in PA for PE students and non-PE students. The results showed that weight stigma had the significantly and negatively indirect effect on four levels of PA for both non-PE and PE students.

(Insert Table 2 and Table 3 here)

Table 4 shows the results of the moderated atemporal mediation analysis conducted using the PROCESS Macro (Model 59), which included four distinct models with different PA levels (i.e., total activity, vigorous, moderate, and walking MET-minutes) as dependent variables. With the factors including sex, health status, age, and BMI being controlled for as covariates, both PWS and major

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groups (non-PE students) showed a significantly relationship to individuals' tendencies to avoid participating in PA (*B* [SE] = 0.94 [0.08] for PWS; and *B* [SE] = -2.61 [0.29] for major group, both *p*s < .01) in the atemporal mediation model, suggesting that (i) higher PWS was associated with higher TAPAS score, and (ii) non-PE students showed a higher inclination to abstain from engaging in sports compared to PE students.

Direct effects were found in the correlations between PWS and four levels of PA (*B* [SE] = -13.67 [4.36], *p* = .001 for total activity, -63.02 [29.14], *p* = .031 for vigorous MET-minutes, -17.21 [8.68], *p* = .048 for moderate MET-minutes, and -49.54 [14.87], *p* = .001 for walking MET-minutes), as well as the correlations between individuals' tendencies to avoid participating in PA and four levels of PA (*B* [SE] = -3.44 [1.09], *p* = .002 for total activity, -38.99 [7.31], *p* < .001 for vigorous MET-minutes, -15.58 [3.27], *p* < .001 for moderate MET-minutes, and -13.99 [3.73], *p* < .001 for walking MET-minutes). In addition, major groups (non-PE students) showed a significant positive association with total activity (*B* [SE] = 104.04 [33.63], *p* = .003) and moderate MET-minutes (*B* [SE] = 240.95 [100.87], *p* = .020), suggesting that PE students engage in more moderate intensity PA compared to non-PE students and thus explain the higher total activity level among PE students.

When considering major group (non-PE students) as moderator in atemporal mediation model, the association of PWS with individuals' tendency to avoid participating in PA, as well as to different levels of PA, were not moderated by different groups (i.e., PE group vs, non-PE group) due to the non-significant interaction term. However, the major group showed a significant influence in the association between individuals' tendency to avoid participating in PA and moderate MET-minutes (*B* [SE] = -9.14 [4.51], *p* = .043), suggesting that compared to non-PE students, PE students showed more reduction in moderate PA with the involvement of PA avoidance tendency (Figure 1). Figure 2 summarizes the results of moderated atemporal mediation models with the dependent variables (i.e., the four levels of PA).

(Insert Table 4, Figure 1 and Figure 2 here)

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Discussion

The present study investigated the mediating effect of the tendency to avoid PA in the association between PWS and PA among PE students and non-PE students. To better understand this issue among the two groups, the present study categorized PA into four types, including the total activity, walking MET-minutes per week, moderate MET-minutes per week, and vigorous MET-minutes per week. The results showed that the significant association of PWS and all types of PA was mediated by the tendency to avoid PA among both PE students and non-PE students. Therefore, the first hypothesis was supported. In addition, PE students were less affected by the tendency to avoid PA when compared to non-PE students. Therefore, the second hypothesis was also supported. However, when the PE students were affected by the tendency to avoid PA, they showed a higher reduction in moderate MET-minutes per week than non-PE students. Therefore, the third hypothesis was not supported.

In addition to the previous studies supporting a 'U-shape' pattern of weight stigma across the weight spectrum (Himmelstein et al., 2018; Pearl et al., 2018), the present study found a significant difference in the level PWS between underweight and obese participants among two groups even when BMI was controlled for. This finding may due to the explicit and implicit preference on weight categories (Marini, 2017). That is, a pro-underweight preference was observed at the explicit level of weight stigma. Therefore, the present measures in assessing weight stigma (i.e., PWSS) may demonstrate a higher level of PWS among participants who were obese than participants who were underweight. Apart from that, the significant effect of tendency to avoid PA found in the present study corresponded with the mechanism proposed by Brewis (2014). More specifically, the mechanisms proposed that weight stigma may directly change the behavior of stigmatized individuals (Brewis, 2014). In addition, the effect of psychosocial stress has also been proposed to indirectly magnify the impact of weight stigma (Brewis, 2014). Weight stigma may act as a threat to social identification and result in individuals being in unfriendly social situations (Hunger et al., 2015). Therefore, to reduce perceived stress, a stigmatized individual may choose not to engage in sport and exercise to

Journal Pre-proof

avoid being publicly devalued, which subsequentially develops to a longer-term avoidance tendency.

A significant atemporal mediation effect of tendency to avoid PA was found in the associations of PWS and four types of PA among non-PE students and PE students. Previous studies have reported that the tendency to avoid PA (usually indirectly) affected the association between weight stigma and PA (Bevan et al., 2021; Pearl et al., 2021), which concur with the present finding. Moreover, other studies further reported the atemporal mediation effect of internalized stigma in reducing the PA (Bevan et al., 2021; Pearl et al., 2015) and one further supported that the involvement of tendency to avoid PA can be changed by internalized stigma (Bevan et al., 2021). This suggests the potential influences of different forms of weight stigma (i.e., PWS and internalized weight stigma) may affect the PA avoidance (Bevan et al., 2021; Pearl et al., 2015) and subsequently reduce PA (Bevan et al., 2021; Pearl et al., 2015; Puhl et al., 2020). A theoretical concept proposed by Ekkekakis et al. (2016) suggested that repeated unpleasant experience during PA may lead to PA avoidance because – from the perspective of hedonism – individuals tend to seek pleasant experiences and avoid unpleasant situations (Murphy & Eaves, 2016). For stigmatized individuals, psychosocial stress (Hunger et al., 2015) such as embarrassment and shame, may be provoked by PWS (Brewis, 2014), resulting in an active avoidance of exercising and subsequently reducing PA (Thedinga et al., 2021).

Being a PE or non-PE major moderated the association between PWS and PA. More specifically, the present results showed that compared to non-PE students, PE students were less affected by tendency to avoid PA. This may be explained by the effect of physical self-concept. Physical self-concept refers to the individual's perception of their appearance and physical ability (Gorospe & Ferrer, 2022). Studies supported the relationship between PA and physical self-concept suggested that PA improves the physical perception and body satisfaction (Arazi & Hosseini, 2013; Fernandez-Bustos et al., 2019; Gorospe & Ferrer, 2022; Ruiz-Montero et al., 2020). That is, physically active individuals may consider themselves as having better physical fitness (e.g., better exercise performance or sport ability) (Ruiz-Montero et al., 2020). Such individuals are more likely to have a positive self-concept regarding their weight which subsequently enhances their psychological well-

Journal Pre-proof

being (Fernandez-Bustos et al., 2019; Ruiz-Montero et al., 2020).

Prior research has also reported that individuals with higher physical self-perception are more physically active (Kipp & Weiss, 2013), which may because improved body satisfaction (Fernandez-Bustos et al., 2019) diminishes the self-protection reason that may trigger the PA avoidance (Myre et al., 2021). It was noteworthy that self-concept may indirectly affect weight stigma because individuals may be affected by weight stigmatization once they consider themselves as being overweight (Hunger et al., 2015). Future research could more specifically examine the factors that influence the development of self-concept (i.e., PA level or body satisfaction) to investigate their associations with PA avoidance tendency. Moreover, intervention studies could be conducted to examine if reducing weight stigma and PA avoidance tendency leads to increases in PA engagement among both PE and non-PE students.

However, a greater reduction of the moderate MET-minutes per week when affected by tendency to avoid PA was found among PE students. That is, compared to non-PE students, PE students reduced their physical participation at moderate level when they started to avoid PA. One study reported that the moderate to vigorous PA for more than 150 minutes/week is one of effective ways to prevent weight gain (Jakicic et al., 2019). However, other studies have reported that internalized weight stigma may directly affect the PA level (Bevan et al., 2021; Mensinger & Meadows, 2017), particularly for moderate PA (Mensinger & Meadows, 2017). Although no previous study has investigated weight-related self-stigmatization among PE students, one study reported greater weight stigmatization among third-year PE university students compared to first-year PE students (O'Brien et al., 2007). These results suggest that PE students may develop their weight bias beliefs during their PE training and may develop internalized weight stigmatization without even noticing they have developed it, and this may become exacerbated during their university education (O'Brien et al., 2007). Speculatively, compared to non-PE majored students, PE students may hold a relatively strict weight norm (Juvonen et al., 2017) and a more negative implicit bias toward individuals who are considered obese, including themselves (Sanjuán et al., 2013) This may explain the finding that greater

Journal Pre-proof

internalized weight stigma held by PE students contributed to a greater reduction in moderate PA level. Nevertheless, other studies have shown that decreased internalized stigmatization (Mensinger & Meadows, 2017) as well as the enjoyment of PA (Bevan et al., 2021; Mensinger & Meadows, 2017) may significantly improve PA engagement. Therefore, strategies to deal with stigmatization such as coping methods for social isolation (Thedinga et al., 2021) can be adopted, and further research should investigate the key factors that improve PA enjoyment.

The present study has several limitations. First, the cross-sectional design adopted by the present study could not provide any evidence for a causal relationship between PWS and PA. Second, the self-reported assessments used in the present study may have introduced some biases such as social-desirability bias (e.g., the participants may report higher PA duration in order to meet the social expectation) or recall bias (e.g., the participants may wrongly remember their PA participation in the past week). Third, the characteristics possessed by the studied populations (i.e., PE majors and/or university students) may limit the generalizability of the present finding. More specifically, the tendency to avoid PA can be affected by numerous factors and each population may demonstrate different impacts. Fourth, height, weight and PA level were not objectively measured, which likely lowered data quality because the data were self-report. Fifth, although several strategies were adopted to ensure the data quality, no quality control question was included in the survey. Therefore, it is possible that some data from participants who did not pay attention to the survey questions were used in the data analysis.

Despite these limitations, the present study has a number of strengths. First, the present study had a very large sample of Chinese university students. The large sample size provided sufficient statistical power which resulted in highly reliable findings and an important contribution to studying weight stigma and PA. Second, to the best of the present authors' knowledge, the present study is the first to investigate the influence of tendency to avoid PA among PE students and provides useful empirical evidence. Third, standardized instruments (i.e., PWSS, TAPAS, and IPAQ-SF) with reliable psychometric properties were used for assessment to collect valid findings.

Journal Pre-proof

As far as the present authors are aware, the present study is the first to examine the relationship between PWS and PA avoidance among an Eastern population. A previous study reported that higher weight stigma was associated with higher motivation to avoid exercise, and turned into lower levels of PA among French and Mexican populations (Rojas-Sanchez et al., 2022). However, no prior evidence has been found among an Eastern population. Therefore, additional evidence provided in the present study adds to the literature that weight stigma across populations with different sociocultural background leads to the same problems in health behaviors.

Based on the present findings, anti-weight stigma strategies such as psychoeducation, motivational interviewing or support group could be adopted by individuals experiencing weight stigma (Nutter et al., 2019). In addition, public education may highlight the harm of labelling to help improve knowledge of stigmatized issues (Harwood et al., 2022). Moreover, stigma-free conditions experienced by individuals in exercise and sports settings may improve PA enjoyment and facilitate PA engagement, subsequently leading to the goal of weight control (Bevan et al., 2021). Future studies could focus on the cultural influence of weight stigmatization and PA avoidance (Rojas-Sanchez et al., 2022), or investigate the determining factors that promote the PA enjoyment to facilitate the active participation of PA (Bevan et al., 2021), to help develop more effective approaches in reducing weight stigmatization.

Journal Pre-proof

Conclusions

The present study investigated the association of PWS with PA and the mediating effect of tendency to avoid PA in the association among two types of university students – those studying general subjects and those studying physical education (i.e., non-PE and PE students). The results showed that the significant association between PWS with PA was mediated by the tendency to avoid PA. In addition, the study found that compared to non-PE students, PE students were less affected by the tendency to avoid PA. However, once PE students have the tendency to avoid PA, they appear to have a greater reduction in moderate PA than that among non-PE students. Based on the present

Journal Pre-proof

findings, weight stigmatization may result in negative consequences of reduced PA among stigmatized individuals.

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Figures

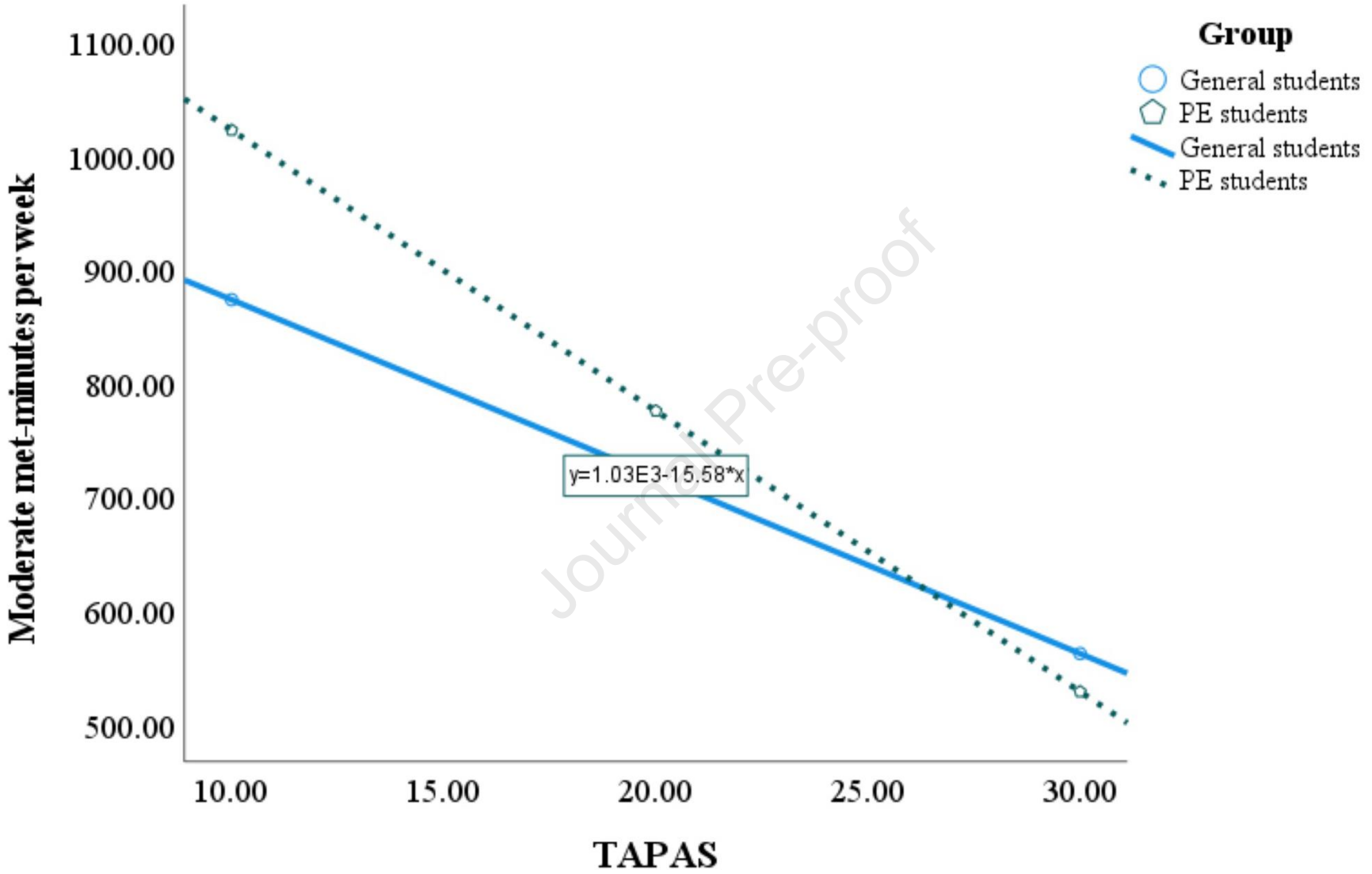

Figure 1. Simple slopes interaction plot showing the interaction effect between TAPAS and major group on moderate MET-minutes per week

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TAPAS = Tendency to Avoid Physical Activity and Sport Scale; PE = Physical education.

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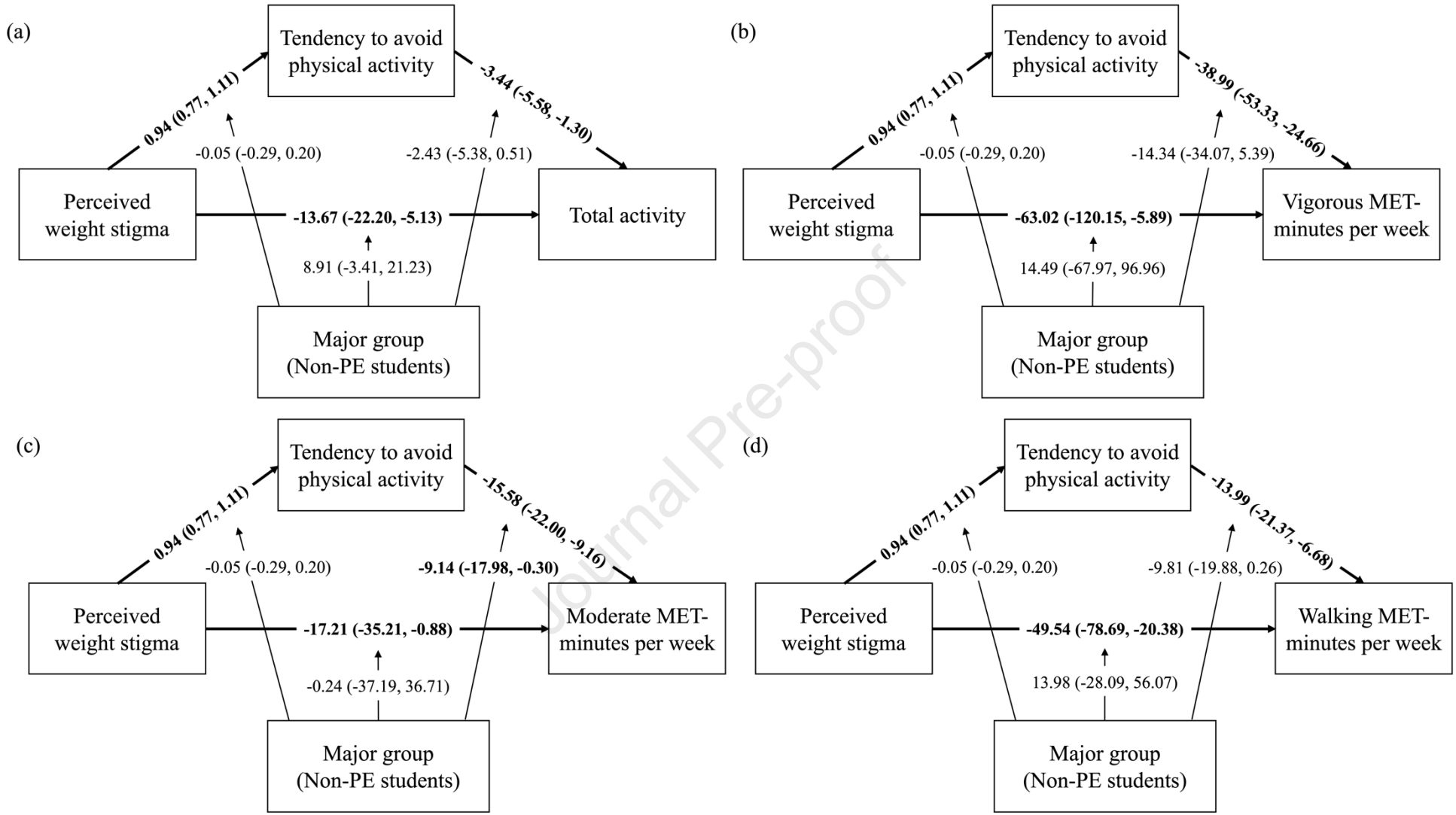

Figure 2. Results of moderated atemporal mediation effect with the dependent variables of (a) total activity, (b) vigorous MET-minutes per week, (c) moderate MET-minutes per week, and (d) walking MET-minutes per week.

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Note: Tendency to avoid physical activity was the mediator and the study major group of non-PE students was the moderator. The moderated atemporal mediation effect (i.e., the effect of major group on each association) is shown in thin lines and the direct effect between variables is shown in bold lines. Significant results are shown in **bold**.

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Tables

Table 1. Comparing the demographic variables between physical education (PE) and non-PE students.

	non-PE students (n = 2877)	PE students (n = 2286)	t or χ^2 (p-value)
Sex (female); n (%)	1656 (57.6)	922 (40.3)	151.22 (<.001)
University (4-year college); n (%)	2035 (70.7)	2241 (98.0)	667.15 (<.001)
Grade; n (%)			608.65 (<.001)
Freshman	808 (28.1)	741 (32.4)	
Sophomore	1102 (38.3)	460 (20.1)	
Junior	340 (11.8)	578 (25.3)	
Senior	609 (21.2)	263 (11.5)	
Graduate student	18 (0.6)	244 (10.7)	
Marital status (single); n (%)	2829 (98.3)	2225 (97.3)	29.58 (<.001)
Disease (yes); n (%)	278 (9.7)	116 (5.1)	38.05 (<.001)
Height (cm)	167.23 (9.19)	174.09 (9.01)	26.87 (<.001)
Weight (kg)	69.88 (26.44)	76.36 (27.61)	8.58 (<.001)
BMI	24.88 (8.77)	25.06 (8.36)	0.74 (.463)
Overweight; n (%)	1018 (35.4)	815 (35.6)	9.62 (.002)

BMI = body mass index. Significant level was adjusted to $p < .006$.

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Table 2. Pearson correlation among weight-stigma, tendency to avoid physical activity and sport, and physical activity in four levels

		Pearson's correlation (*df* = 2875 for non-PE students; = 2284 for PE students)						
non-PE students (*n* = 2877)	Mean (*SD*)	1	2	3	4	5	6	7
1. BMI	24.88 (8.77)	-						
2. PWSS	1.33 (2.21)	.068***	-					
3. TAPAS	23.33 (8.63)	.037*	.235***	-				
4. Total activity	265.82 (389.02)	.015	-.097***	-.096***	-			
5. Vigorous MET-minutes per week	1621.42 (2617.25)	-.021	-.078***	-.148***	.499***	-		
6. Moderate MET-minutes per week	676.43 (1149.77)	-.006	-.062**	-.125***	.492***	.492***		
7. Walking MET-minutes per week	1407.43 (1407.51)	.001	-.105***	-.103***	.550***	.325***	.359***	-
PE students (*n* = 2286)	Mean (*SD*)	1	2	3	4	5	6	7
1. BMI	25.06 (8.36)	-						
2. PWSS	0.88 (1.92)	.061*	-					
3. TAPAS	19.30 (8.43)	.038	.200***	-				
4. Total activity	347.78 (431.16)	-.001	-.044*	-.123***	-			
5. Vigorous MET-minutes per week	1948.07 (2949.42)	.029	-.057*	-.172***	.472***	-		
6. Moderate MET-minutes per week	792.97 (1314.49)	.021	-.057**	-.166***	.478***	.549***	-	
7. Walking MET-minutes per week	1317.22 (1419.79)	-.020	-.080***	-.151***	.502***	.373***	.396***	-

BMI = Body Mass Index; PWSS = Perceived Weight Stigma Scale; TAPAS = Tendency to Avoid Physical Activity and Sport Scale; MET = Metabolic Equivalent of Task; PE = Physical Education. *$p < .05$; **$p < .01$. Significance level was adjusted to ***$p < .002$.

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Table 3. Simple mediated effects among non-PE students and PE students

Effect Moderator level	Estimate	Standard Error	Lower	Upper
PWS ⇒ Tendency to avoid physical activity ⇒ Total activity				
non-PE students	-3.24	1.11	-5.63	-1.25
PE students	-5.25	1.18	-7.73	-3.17
PWS ⇒ Tendency to avoid physical activity ⇒ Vigorous MET-minutes				
non-PE students	-36.70	8.14	-54.21	-22.44
PE students	-47.61	8.95	-67.07	-31.86
PWS ⇒ Tendency to avoid physical activity ⇒ Moderate MET-minutes				
non-PE students	-14.66	3.49	-22.05	-8.20
PE students	-22.06	4.02	-30.86	-14.81
PWS ⇒ Tendency to avoid physical activity ⇒ Walking MET-minutes				
non-PE students	-13.17	3.99	-21.76	-5.94
PE students	-3.24	1.11	-5.63	-1.25

PE = Physical Education; MET = Metabolic equivalent of task.

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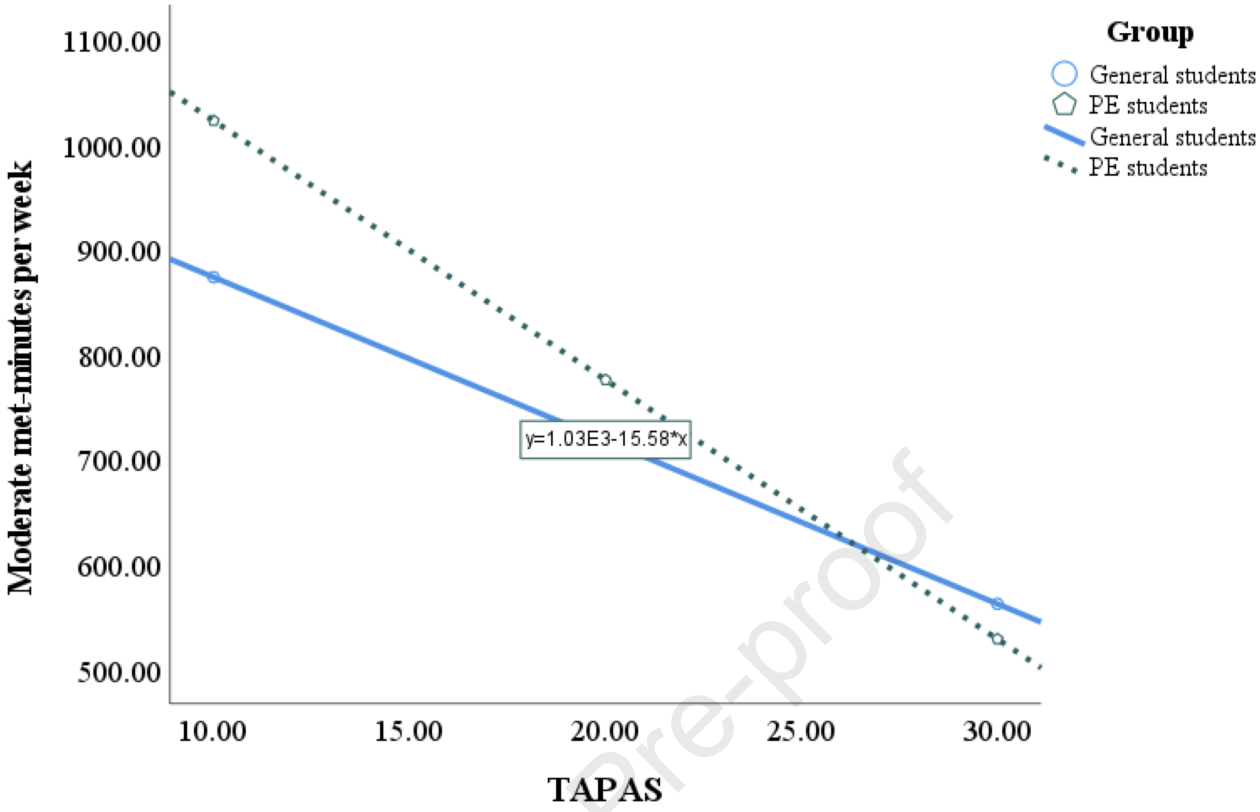
Table 4. Outcomes from PROCESS Macro (Model 59): Examining the indirect effect of weight stigma on physical activity via avoidance tendencies, moderated by non-PE students and PE students.

Variables	Total activity (min/wk)			Vigorous MET-minutes per week			Moderate MET-minutes per week			Walking MET-minutes per week		
	B (SE)	Bootstrapping		*B* (SE)	Bootstrapping		*B* (SE)	Bootstrapping		*B* (SE)	Bootstrapping	
		LLCI	ULCI		LLCI	ULCI		LLCI	ULCI		LLCI	ULCI
Mediator variable (i.e., the tendency to avoid PA) model												
Constant	17.57 (1.04)	15.54	19.61	17.57 (1.04)	15.54	19.61	17.57 (1.04)	15.54	19.61	17.57 (1.04)	15.54	19.61
Sex (Male)	1.67 (0.26)**	1.16	2.17	1.66 (0.25)**	1.16	2.17	1.66 (0.25)**	1.16	2.17	1.66 (0.25)**	1.16	2.17
Disease (No)	0.67 (0.49)	-0.30	1.64	0.67 (0.49)	-0.30	1.64	0.67 (0.49)	-0.30	1.64	0.67 (0.49)	-0.30	1.64
Age	-0.02 (0.03)	-0.09	0.05	-0.02 (0.03)	-0.09	0.05	-0.02 (0.03)	-0.09	0.05	-0.02 (0.03)	-0.09	0.05
BMI	0.04 (0.01)*	0.01	0.06	0.04 (0.01)*	0.01	0.06	0.04 (0.01)*	0.01	0.06	0.04 (0.01)*	0.01	0.06
Weight-stigma	0.94 (0.08)**	0.77	1.11	0.94 (0.08)**	0.77	1.11	0.94 (0.08)**	0.77	1.11	0.94 (0.08)**	0.77	1.11
Major group (non-PE students)	-2.61 (0.29)**	-3.19	-2.03	-2.61 (0.29)**	-3.18	-2.02	-2.61 (0.29)**	-3.18	-2.02	-2.61 (0.29)**	-3.18	-2.02
Stigma × Major group	-0.05 (0.12)	-0.29	0.20	-0.05 (0.12)	-0.29	0.20	-0.05 (0.12)	-0.29	0.20	-0.05 (0.12)	-0.29	0.20
Dependent variable (i.e., the level of PA) model												
Constant	516.91 (55.88)	407.33	626.46	4738.76 (374.05)	4005.43	5472.09	1412.57 (167.60)	1083.98	1741.16	2316.44 (190.89)	1942.19	2690.68
Sex (Male)	-24.61 (12.85)	-49.81	0.58	-715.46 (86.02)**	-884.11	-546.82	-40.38 (38.54)	-115.95	35.17	51.67 (43.89)	-34.39	137.73
Disease (No)	-35.63 (24.49)	-83.66	12.39	-194.53 (163.96)	-515.98	126.93	-72.04 (73.46)	-216.08	71.99	-73.07 (83.67)	-237.12	90.97
Age	-4.71 (1.71)**	-8.07	-1.34	-44.99 (11.48)**	-67.52	-22.47	-14.14 (5.14)*	-24.23	-4.06	-28.17 (5.86)**	-39.66	-16.67
BMI	0.63 (0.73)	-0.81	2.06	3.51 (4.88)	-6.06	13.09	2.50 (2.18)	-1.79	6.79	1.17 (2.49)	-3.72	6.06
Weight-stigma	-13.67 (4.36)**	-22.20	-5.13	-63.02 (29.14)**	-120.15	-5.89	-17.21 (8.68)*	-35.21	-0.88	-49.54 (14.87)**	-78.69	-20.38
TAPAS	-3.44 (1.09)**	-5.58	-1.30	-38.99 (7.31)**	-53.33	-24.66	-15.58 (3.27)**	-22.00	-9.16	-13.99 (3.73)**	-21.31	-6.68
Major group (non-PE students)	104.04 (33.63)**	38.09	169.98	351.59 (225.12)	-89.76	792.95	240.95 (100.87)*	43.19	438.71	61.13 (114.89)	-164.11	206.37
Stigma × Major group	8.91 (6.28)	-3.41	21.23	14.49 (42.06)	-67.97	96.96	-0.24 (18.85)	-37.19	36.71	13.98 (21.47)	-28.09	56.07
TAPAS × Major group	-2.43 (1.50)	-5.38	0.51	-14.34 (10.06)	-34.07	5.39	-9.14 (4.51)*	-17.98	-0.30	-9.81 (5.14)	-19.88	0.26

PE = physical education; BMI = body mass index; MET = metabolic equivalent; SE = standard error; LLCI = lower limit confidence interval; ULCI = upper limit confidence interval; TAPAS = Tendency to Avoid Physical Activity and Sport Scale; PA = physical activity. *$p < .05$; **$p < .01$.



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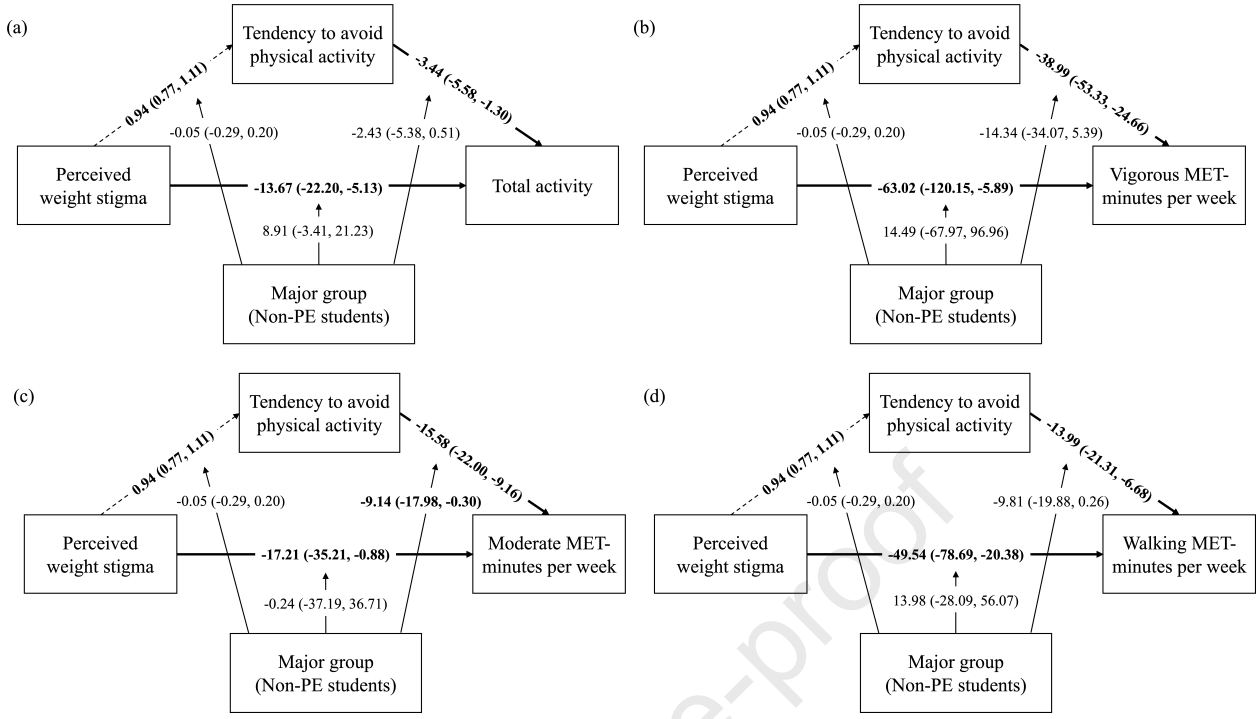

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Highlights

- Perceived weight stigma (PWS) may reduce individuals' physical activity (PA)
- Physical education (PE) students were compared with general subject (GS) students
- The significant association between PWS and PA was found among university students.
- Results further showed the mediation effect of tendency to avoid PA among groups.
- PE students were less-affected by trend of PA when compared to GS students.

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Declaration of interests

☒ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

☐The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

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