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Association between problematic social media use and physical activity: the mediating roles of nomophobia and the tendency to avoid physical activity

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Highlights

- Insufficient physical activity is now a global issue.
- Problematic social media use (PSMU) has no direct association with physical activity
- Nomophobia and physical activity avoidance were significantly related.
- PSMU was associated with physical activity via the mediation of nomophobia and physical activity avoidance.

Abstract

Insufficient physical activity is now a global pandemic. Problematic social media use (PSMU) has been reported to be associated with physical activity levels, and nomophobia can be one of the co-existing psychological conditions of PSMU. Additionally, physical activity avoidance has been reported to be associated with lower physical activity levels. Therefore, the present study examined nomophobia and physical activity avoidance as underlying factors potentially explaining the association between PSMU and physical activity among Taiwanese young adults. A cross-sectional online survey comprising the Bergen Social Media Addiction Scale (BSMAS), Nomophobia Questionnaire (NMPQ), Tendency to Avoid Physical Activity and Sport Scale (TAPAS), and International Physical Activity Questionnaire – short form (IPAQ-SF) was completed by 885 participants (36% male, mean age = 28.8 ± 6.06 years) between September and December 2023. The structural equational modeling results indicated a negative direct association between PSMU and physical activity (standardized coefficient [β] = 0.040, p = 0.004). PSMU was also associated with higher nomophobia (β = 0.601, p < 0.001), which was associated with higher physical activity avoidance (β = 0.354, p < 0.001), which negatively correlated to physical activity (β = -0.114, p < 0.001). Moreover, the association between PSMU and physical activity was significantly mediated through the sequence of nomophobia and PA avoidance (β = -0.024, 95% bootstrap confidence interval = -0.071, -0.024). The results suggested that PSMU may be associated with lower physical activity through the mediation of nomophobia and physical activity avoidance. Corresponding strategies may aim to reduce PSMU and enhance physical activity engagement. Other approaches, such as motivational interviewing or cognitive behavioral therapy, can be adopted to reduce nomophobia and physical activity avoidance, thereby improving the individuals' physical activity participation.

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1. Introduction

Insufficient physical activity (PA) has become a global health concern (Haseler et al., 2022). The World Health Organization suggests that adults engage in at least 150 minutes of moderate PA or at least 75 minutes of vigorous PA per week (World Health Organization, 2020). However, one in four adults does not meet the recommended PA levels (World Health Organization, 2022). The global decline in PA levels across different age groups has become widespread, leading to potential increases in future health expenditures (Duijvestijn et al., 2023). Regular PA is well-documented for its benefits, including improvements in mental health and sleep quality and reductions in the risks of cardiovascular diseases and certain cancers (Haseler et al., 2022). Conversely, insufficient PA is linked to obesity, metabolic disorders such as type 2 diabetes or hypertension (Duijvestijn et al., 2023; Haseler et al., 2022), and higher all-cause mortality rates (Duijvestijn et al., 2023). Therefore, research is urgently needed to investigate factors influencing PA engagement.

Social media use (SMU) is a potential contributor to sedentariness (Alley et al., 2017), with a complex association with PA. Social media has become an integral part of modern society, enhancing access to the world through instant information and real-time communication. It allows individuals to connect with others and frequently receive updates. Building on theories such as the Uses and Gratification Theory (Ruggiero, 2000) and the Media System Dependency Theory (Ball-Rokeach, 1998), it has been shown that a minority of users may develop problematic social media use (PSMU). PMSU is characterized by excessive social media use, leading to negative consequences such as psychological distress (Huang et al., 2023) and insomnia (Lin et al., 2021), and may impair individuals' ability to fulfill daily responsibilities, including regular PA (Andreassen, 2015; Blackwell et al., 2017). However, previous research has shown mixed results, including negative (Ardesch et al., 2023), positive (Huang et al., 2022; Shimoga et al., 2019), and no associations between PMSU and PA (Yılmaz et al., 2023). This calls for more attention to potential mediators that could explain these mixed results.

A psychological condition that frequently accompanies PSMU is nomophobia (King et al., 2010; King et al., 2013; Lin et al., 2021). Nomophobia is a sense of discomfort or anxiety caused by not having access to one's virtual communication device (e.g., smartphone or laptop) (King et al., 2010; King et al., 2013; Yildirim et al., 2015). Building on the Media System Dependency Theory (Ball-Rokeach, 1998), the more functions a medium provides (e.g., instant updates, entertainment, or communication opportunities), the greater the users' dependency. Several recent studies reported associations between SMU and nomophobia (Ayar et al., 2018; Khan et al., 2021; Lin et al., 2021). For instance, individuals with social phobia may prefer virtual interactions to avoid face-to-face communication (King et al., 2013), potentially leading to a dependency on their devices and subsequently developing nomophobia (King et al., 2013; Yildirim et al., 2015). Similar to PSMU, previous studies on the relationship between nomophobia and PA have produced contradictory results, reporting negative (Torlak et al., 2022), positive (Liu et al., 2022), and no associations (Demircioğlu et al., 2023), which may be attributed to the types of apps the individuals used or the psychological context behind nomophobia (e.g., avoidant trait).

Among the various factors that may affect PA, the tendency to avoid PA (i.e., PA avoidance) has recently been proposed (Bevan et al., 2022) and investigated in several studies (Huang et al., 2024; Saffari et al., 2024; Yi et al., 2024). PA avoidance refers to avoiding exercise or sports activities for fear of being judged or perceived. Individuals concerned about their physical appearance or abilities may feel stressed when performing PA in public, thus developing a tendency to avoid such scenarios (Bevan et al., 2022; Yi et al., 2024). Several studies have examined the impact of PA avoidance on individuals' PA engagement and reported significant negative associations or mediation effects, suggesting that PA avoidance may reduce PA levels (Huang et al., 2024; Saffari et al., 2024; Yi et al., 2024).

Currently, the relationship between PSMU, nomophobia, and PA avoidance is less investigated. In addition, to the best of the present authors' knowledge, the collective influence of these factors on PA levels has not yet been investigated. Given the inconsistent results found in the association between PSMU and PA, further investigation is warranted to clarify the underlying mechanisms and develop corresponding strategies to improve PA levels. The link between PMSU and nomophobia is clear and established, as is the link between PA avoidance and PA engagement. However, the link between nomophobia and PA avoidance is less clear. Therefore, the present study proposes to investigate the associations between PSMU, nomophobia, PA avoidance, and PA level (see Figure 1 for the hypothetical model). We hypothesize that (i) PSMU has a direct effect on PA, though the direction is unknown due to the mixed results in prior research, (ii) significant positive associations exist between nomophobia and PA avoidance, and (iii) nomophobia and PA avoidance significantly mediate the association between PSMU and PA.

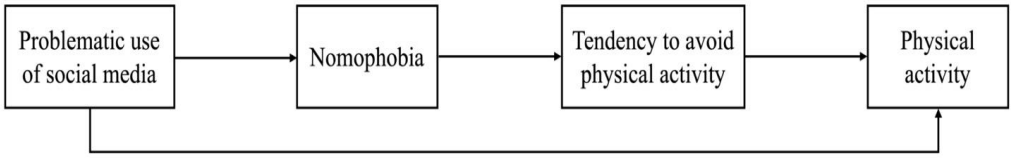

Figure 1. Proposed Model of Present Study.

2. Method

2.1. Participants, Procedure, and Ethical Considerations

This cross-sectional study used convenience and snowball sampling to recruit participants via an online survey created with SurveyMonkey. The survey was distributed between September and December 2023 among Taiwanese young adults. Participants were eligible if they (i) were aged between 20 and 40 years and (ii) had at least one active social media account. Additionally, participants were encouraged to share the survey with others who met these criteria.

The study adhered to the ethical standards of the 1964 Declaration of Helsinki. All participants provided informed consent before participating. The first page of the online survey displayed the informed consent form, and by clicking 'agree,' participants proceeded to the survey questions; clicking 'no' ended the survey immediately, preventing further access. The National Cheng Kung University Human Research Ethics Committee approved the study on July 11, 2023 (approval number: NCKU HREC-E-111-563-2). Two questions regarding the birth year and the current social media platforms were included to check for eligibility. Responses that did not meet the eligibility were removed. Participants who completed the survey received 200 New Taiwan dollars (approximately 6 US dollars) as compensation for their time. During the study period, 1211 participants accessed the online survey. Of these, 211 terminated the survey early, 38 completed it twice, and 75 did not meet the inclusion criteria (i.e., indicated their age under 20 or had no activated social media account). In addition, 2 participants reported unreasonable daily time spent on smartphones (i.e., 23 and 24 hours per day). Consequently, data from 885 participants were included in the final analysis.

2.2. Measures

Demographic variables, including age, sex, height, and weight (used to calculate body mass index), as well as daily time spent on smartphones and outdoor activities, were measured. Additionally, four measures were used to assess the variables of interest: PSMU, nomophobia, PA avoidance, and PA level.

2.2.1. Bergen Social Media Addiction Scale (BSMAS)

The Bergen Social Media Additional Scale (BSMAS), developed by Andreassen et al. (2017), assessed individuals' social media addiction levels. It comprises six items rated on a five-point Likert-like scale (1 = seldom; 5 = very often), resulting in a total score ranging from 6 to 30. Higher scores indicate a higher level of social media addiction. An example item is "*You feel an urge to use social media more and more*". The Chinese version of the BSMAS has demonstrated robust psychometric properties (Chen et al., 2020; Leung et al., 2020) and showed strong internal consistency in the present study (Cronbach's $\alpha = 0.900$).

2.2.2. Nomophobia Questionnaire (NMPQ)

The Nomophobia Questionnaire (NMPQ), developed by Yildirim et al. (2015), was used to evaluate individuals' fear of being without access to their smartphones. It consists of 20 items rated on a seven-point Likert-like scale (1 = strongly disagree; 7 = strongly agree), resulting in a total score ranging from 20 to 140. Higher scores indicate a higher level of fear associated with lacking access to one's smartphone. An example item is "*Running out of battery on my smartphone would scare me*." The Chinese version of the NMPQ has demonstrated satisfactory psychometric properties (Gao et al., 2020) and showed excellent internal consistency in the present study ($\alpha = 0.962$).

2.2.3. Tendency to Avoid Physical Activity and Sport Scale (TAPAS)

The Tendency to Avoid Physical Activity and Sport (TAPAS), developed by Bevan et al. (2022), assessed individuals' tendency to avoid engaging in PA, exercise, or sports. It comprises ten items rated on a five-point Likert-like scale (1 = strongly disagree; 5 = strongly agree), resulting in a total score ranging from 10 to 50. Higher scores indicate a higher tendency to avoid participating in any form of PA. An example item is "I *worry about participating in sports because I do not like how my body looks when playing sports*." The Chinese version of the TAPAS has demonstrated robust psychometric properties (Fan et al., 2023; Lin et al., 2024; Saffari et al., 2023) and showed excellent internal consistency in the present study (α = 0.948).

2.2.4. International Physical Activity Questionnaire – short form (IPAQ-SF)

The International Physical Activity Questionnaire (IPAQ), developed by Craig et al. (2003) and the IPAQ Research Committee (2005), was used to assess individuals' PA levels over the past week. It comprises seven items investigating time spent on several levels of PA (i.e., vigorous, moderate, walking, and sitting). Vigorous PA, moderate PA, and walking consisted of two questions each, one measuring frequency (e.g., During the last 7 days, how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?), the other measuring time spent on the activity (e.g., How much time did you usually spend doing vigorous physical activities on one of those days?). For sitting, individuals were asked how much time they spent sitting in the past week. The Chinese version of the IPAQ-SF has demonstrated adequate psychometric properties (Deng et al., 2008; Macfarlane et al., 2007).

In the current study, the time spent on each level of PA was calculated and summed to represent participants' weekly PA level. Weekly frequency multiplied by the time spent on each PA level was further multiplied by its corresponding metabolic equivalents (METs) (8 METs for vigorous activities, 4 METs for moderate activities, 3.3 METs for walking, and 1 METs for sitting) to generate the total weekly PA level in the unit of METs*minutes. Higher scores indicate a higher PA level over the past week.

2.3. Data Analysis

Data was summarized using descriptive analysis, and correlations between variables were calculated using Pearson's correlation coefficient. Structural equation modeling (SEM) with the diagonally weighted least squares estimator was used to examine the model fit. Age and sex were controlled for as covariates. Four fit indices, including comparative fit index (CFI), Tucker–Lewis index (TLI), root mean square error of approximation (RMSEA), and standardized root mean squared residual (SRMR), were employed to examine the supportiveness of the model. Acceptable fit was determined by CFI and TLI values above 0.95 and RMSEA and SRMR below 0.06 and 0.08, respectively (Bentler, 1990; Hu et al., 1999). After confirming that the model was supported, the associations between study variables were determined using the standardized coefficient (β). To test the mediation effects, 599 bootstrapping resamples were used (Wilcox, 2010). A mediation effect was considered significant if the 95% bootstrap confidence interval (CI) did not include 0 (Ramachandran et al., 2020). SEM was performed using the lavaan package (Rosseel, 2012) in R version 4.2.1 (The R Development Core Team, 2022). Descriptive analysis and Pearson's correlation were conducted using SPSS 29.0 (IBM). A significance level of $p < 0.05$ was set for all analyses.

2.3.1. Sample size estimation

Given that SEM was the primary statistical analysis method used in the present study, the following rule of thumb was applied: (i) 10 participants per variable and (ii) a minimum sample size of 100 to 200 participants to estimate the sample size for SEM (Wolf et al., 2013). However, considering the bootstrapping method used to evaluate the indirect effect, a sample size of at least 500 participants was suggested to avoid Type I error (Newsom, 2023). Therefore, a minimum of 500 participants was determined as the sample size for the present study.

3. Results

Participants' characteristics are presented in Table 1 with the score of four measures and the range demonstrated. Of the 885 participants, 36.0% were male (n = 319), with a mean age of 28.8 years (SD = 6.06) and an average daily smartphone usage of 5.21 hours (SD = 2.88). The correlation between targeted variables is shown in Table 2. Daily time spent on the smartphone was significantly correlated with BSMAS (r = 0.237, p

< 0.001), NMPQ (r = 0.213, p < 0.001), and TAPAS (r = 0.180, p < 0.001), but not with IPAQ (r = -0.048, p = 0.156). Conversely, daily time spent on outdoor activity was negatively correlated with NMPQ (r = -0.078, p = 0.020) and TAPAS (r = -0.092, p = 0.006) and positively correlated with IPAQ (r = 0.342, p < 0.001), but not BSMAS (r = 0.048, p = 0.157). Moreover, significant correlations were observed among the four measures (|r| = 0.098 to 0.519), except between BSMAS and IPAQ (r = 0.030, p = 0.375).

Table 1. Baseline Characteristics of Participants (n=885)

Variable	n (%) or Mean ± SD	Minimum	Maximum
Age (years)	28.8 ± 6.06	20	40
Sex (male)	319 (36.0)	-	-
BMI (kg/m^2)	22.82 ± 4.00	14.69	48.67
Smartphone time (hours per day)	5.21 ± 2.88	1	19
Outdoor time (hours per day)	1.80 ± 2.20	0	20
BSMAS (range: 6-30)	14.38 ± 5.19	6	30
NMPQ (range: 20-140)	90.50 ± 25.73	20	140
TAPAS (range: 5-50)	25.31 ± 9.71	10	50
IPAQ (MET*minutes)	3138.21 ± 2940.96	0	15912

BMI, Body Mass Index; BSMAS, Bergen Social Media Addiction Scale; NMPQ, Nomophobia Questionnaire; TAPAS, Tendency to Avoid Physical Activity and Sport Scale; IPAQ, International Physical Activity Questionnaire.

Table 2. Correlation between Study Variables (n= 885)

	1	2	3	4	5	6	7	8	9
[1] Age	-								
[2] Sex	**-0.140 (<0.001)**	-							
[3] BMI	**0.136 (<0.001)**	**-0.201 (<0.001)**	-						
[4] Smartphone time	-0.039 (0.249)	**0.076 (0.024)**	0.036 (0.281)	-					
[5] Outdoor time	-0.043 (0.206)	**-0.079 (0.018)**	-0.027 (0.420)	0.058 (0.084)	-				
[6] BSMAS	-0.027 (0.426)	0.057 (0.091)	**-0.075 (0.025)**	**0.237 (<0.001)**	0.048 (0.157)	-			
[7] NMPQ	0.015 (0.650)	0.051 (0.131)	0.005 (0.887)	**0.213 (<0.001)**	**-0.078 (0.020)**	**0.519 (<0.001)**	-		
[8] TAPAS	0.017 (0.621)	**0.128 (<0.001)**	**0.235 (<0.001)**	**0.180 (<0.001)**	**-0.092 (0.006)**	**0.350 (<0.001)**	**0.309 (<0.001)**	-	
[9] IPAQ	-0.028 (0.404)	-0.060 (0.073)	-0.033 (0.324)	-0.048 (0.156)	**0.342 (<0.001)**	0.030 (0.375)	**-0.123 (<0.001)**	**-0.101 (0.003)**	-

BMI, Body Mass Index; BSMAS, Bergen Social Media Addiction Scale; NMPQ, Nomophobia Questionnaire; TAPAS, Tendency to Avoid Physical Activity and Sport Scale; IPAQ, International Physical Activity Questionnaire. Significance is shown in bold; p-value is shown in parentheses.

The proposed model demonstrated a good fit to the data, as indicated by all four indices from SEM (CFI = 0.971, TLI = 0.969, RMSEA = 0.062, and SRMR = 0.073; see Figure 2). The associations between variables were further examined using the significant standardized coefficients (β). In line with the hypothesis (i), a significant direct association was found between PSMU and PA level (β = -0.040, p = 0.004) (ii) nomophobia was positively associated with PSMU (β = 0.601, p < 0.001), and PA avoidance (β = 0.354, p < 0.001). PA avoidance was also negatively associated with PA level (β = -0.114, p < 0.001). Finally, confirming hypothesis (iii), a significant indirect association was found between PSMU and PA via the sequential mediation of nomophobia and PA avoidance (unstandardized coefficient (SE) = -0.084 (0.026), β = -0.024, 95% bootstrap confidence interval = -0.071, -0.024). This means that higher levels of PSMU are indirectly associated with lower levels of PA via greater nomophobia and PA avoidance, whereby nomophobia precedes PA avoidance.

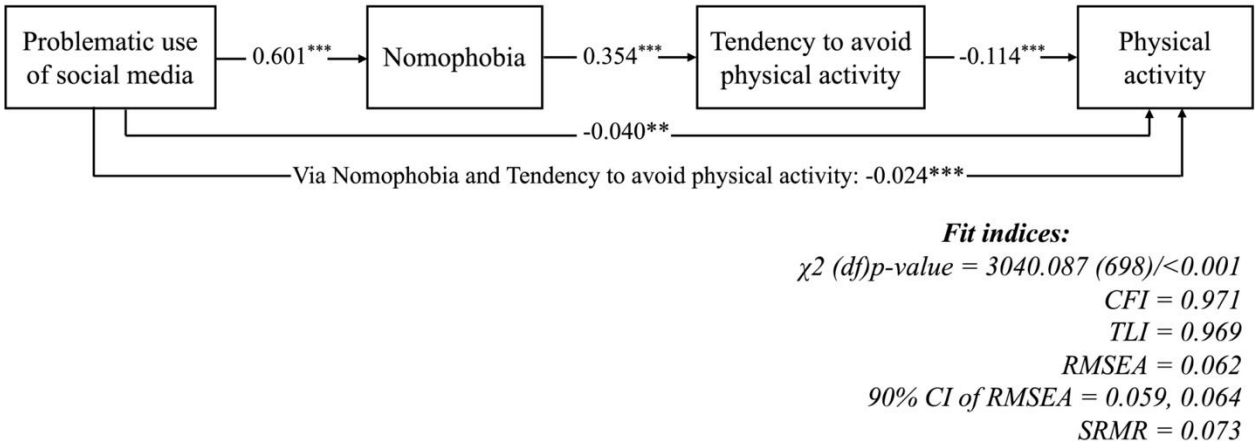

Figure 2. Results of Structural Equation Modeling.

Notes. CFI, comparative fit index; TLI, Tucker-Lewis index; RMSEA, root mean square error of approximation; SRMR, standardized root mean squared residual. Data was presented using standardized coefficients. Solid lines indicate significant associations, and the dashed line indicates non-significant associations. ** $p < 0.01$; ***$p < 0.001$.

4. Discussion

The present study investigated the association between PSMU, nomophobia, PA avoidance, and PA levels among Taiwanese young adults. Our results suggested a direct association between PSMU and PA. In addition, higher levels of PSMU may result in lower PA levels through increased nomophobia and a higher PA avoidance tendency.

The significant negative direct association between PSMU and PA is consistent with a previous cross-sectional study (Ardesch et al., 2023). However, the finding contradicts results from a longitudinal study which reported a positive association (Huang et al., 2022), and two other cross-sectional studies which reported positive (Shimoga et al., 2019) and non-significant associations (Yılmaz et al., 2023) between PSMU and PA. Shimoga et al. (2019) reported that SMU was positively associated with vigorous PA among physically active individuals but negatively associated with vigorous PA among physically inactive (sedentary) individuals. Moreover, they found that individuals with medium-level SMU had the highest level of PA, which suggests that the association between PSMU and PA may not be a simple linear one. Therefore, future research should explore the factors influencing how SMU affects PA levels to uncover the underlying mechanism between PSMU and PA and determine the optimal level of SMU. Potential areas of investigation include the amount of time spent on social media, types of social media platforms (e.g., YouTube vs. WhatsApp), purposes of using social media (e.g., communication, entertainment, or searching information), and usage habits (e.g., active users or passive users, creators or viewers).

A novel finding of this study is the significant positive association between nomophobia and PA avoidance, which aligns with findings from one previous study (Liu et al., 2022). This finding offers new insights into how SMU may affect PA levels. One previous study reported an association between nomophobia and social appearance anxiety, suggesting that individuals with anxiety about their appearance tend to use social media to hide their identities, leading to a dependency on mobile devices and causing nomophobia (Ayar et al., 2018). Furthermore, the concept of TAPAS was also developed building on weight stigma research (the discrimination or devaluation from others due to one's weight), assuming that individuals concerned about their weight might avoid public PA to escape judgment about their physical appearance (Bevan et al., 2022). These findings suggest that nomophobia and PA avoidance share a common underlying concern related to physical appearance. This notion is further supported by studies reporting associations between nomophobia and internalized weight stigma (Liu et al., 2022) and between TAPAS and weight stigma (Huang et al., 2024). Future studies may consider including factors such as 'weight stigma' or 'physical appearance concerns' when investigating the mechanisms involving nomophobia and PA avoidance.

Another plausible assumption that may explain the association between nomophobia and PA avoidance is the psychological status of 'anxiety.' A quantitative study reported that while exercise generally has an anxiolytic effect, individuals with anxiety-related disorders tend to avoid PA (Mason et al., 2019). Specifically, individuals with anxiety-related disorders (e.g., obsessive-compulsive disorder, post-traumatic stress disorder, or specific phobia that may include nomophobia) may experience anxiety related to PA, such as unpleasant past

exercise experiences or adverse responses to the physical sensations associated with exercise. In these cases, the anxiety provoked by the thought of engaging in PA can lead to a tendency to avoid it altogether (Farris et al., 2020; Mason et al., 2023). For these individuals, the perceived negative aspects of PA may outweigh the potential benefits, making PA avoidance a temporary relief from their anxiety (Mason et al., 2019). Furthermore, nomophobia has been associated with social anxiety (Khan et al., 2021), which is associated with social avoidance (Wong et al., 2016) and could extend to PA avoidance (Horenstein et al., 2021). Considering the role of anxiety in both nomophobia and PA avoidance, cognitive behavioral techniques could be investigated as potential interventions to reduce PA avoidance caused by anxiety (Mason et al., 2023). The potential additive effects of nomophobia on PA avoidance warrant further exploration to understand these dynamics better.

One more possible explanation for the relationship between nomophobia and PA avoidance is the shared psychological mechanism of 'avoidance.' Research indicates that nomophobia is associated with social anxiety (Khan et al., 2021). Individuals experiencing these social difficulties might use social media as an 'escape' from real-life interactions, leading to a reliance on their devices (Arpaci et al., 2017). Similarly, PA avoidance involves individuals steering clear of PA to avoid negative judgments or devaluation from others (Bevan et al., 2022). Thus, both nomophobia and PA avoidance represent strategies of avoidance aimed at escaping negative experiences. This common thread suggests that these behaviors may stem from underlying avoidant personality traits, though more studies are needed to explore these connections in more detail. Future studies could investigate how individual characteristics such as avoidant personality or fear of negative evaluation contribute to both nomophobia and PA avoidance. Exploring these relationships might reveal more profound insights into how psychological avoidance mechanisms influence behavior in different contexts.

The abovementioned notions may explain the weak association between PA avoidance and PA found in the present study. In other words, weight stigma might not be the only explanatory factor of PA avoidance; both the psychological condition of anxiety and personality traits of avoidance could also play a role in PA avoidance. In addition, Kagawa et al. (2022) reported a positive association between subjective pleasure and PA through decreasing avoidance tendencies, suggesting that PA enjoyment may also influence the tendency of PA avoidance (Bevan et al., 2022). Therefore, the current TAPAS measure could be enhanced by modifying its focus beyond weight stigma. Specifically, future research might benefit from revising TAPAS to encompass a broader range of avoidance-related factors, including anxiety and general avoidant personality traits. These adjustments could improve TAPAS's utility in studies investigating the underlying mechanisms of PA avoidance and provide more comprehensive insights into how different psychological factors contribute to PA behavior.

The current study has several limitations. First, being a cross-sectional study, causality between study variables cannot be inferred. Second, using self-reported measures may introduce research bias, such as recall bias or social-desirability bias, which could affect the accuracy of the responses. Third, the convenience and snowball sampling may cause selection bias due to the lack of geographic information on participants, which may limit the generalizability. Fourth, focusing on general young adults as the study population may limit the external validity and generalizability of the results. Further research should consider including clinically significant populations, such as those with addictive SMU, to explore these mechanisms in a more specific context.

Despite these limitations, the present study proposed a new way of thinking regarding how PSMU may reduce individuals' PA levels through nomophobia and PA avoidance. In addition to strategies aimed at monitoring the time spent on SMU or increasing PA motivation, future research could explore cognitive behavioral techniques or motivational interviewing as methods to mitigate nomophobia and PA avoidance. Additional approaches might also consider interventions focused on reducing anxiety, avoidant personality traits, or weight stigma as additional factors influencing PA behaviors. However, more studies are needed to investigate their roles. Furthermore, these studies could adopt longitudinal effects to assess how these factors interact and better understand their roles in the mechanisms connecting nomophobia and PA avoidance.

5. Conclusion

The present study offers new insights into how PSMU might affect PA levels through the mediating roles of nomophobia and PA avoidance among Taiwanese young adults. The results showed that while PSMU has no direct association with PA levels, it was associated with decreased PA levels via higher nomophobia and PA avoidance. It highlights the need for interventions to reduce PSMU and foster PA. Future research should consider expanding the scope to include psychological factors like anxiety and personal traits such as avoidance, as well as exploring weight stigma's role in current mechanisms. This exploration could provide valuable insights

into the factors contributing to PA avoidance and help develop more effective intervention programs to promote PA and address the impacts of PSMU.

Statement of Researchers

Researchers' contribution rate statement:
P-CH: Conceptualization, methodology, software, formal analysis, investigation, resources, data curation, writing—original draft preparation, visualization. FG: methodology, software, validation, formal analysis, writing—review and editing. H-FT: methodology, validation, data curation, writing—review and editing. XC-CF: validation, investigation, data curation, writing—review and editing. C-YC: Conceptualization, investigation, resources, writing—review and editing, supervision, project administration

Conflict statement:
The authors declare that they have no conflict of interest.

Data Availability Statement:
The data supporting this study's findings are available from the corresponding author upon reasonable request.

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Ethical Considerations:
The National Cheng Kung University Human Research Ethics Committee approved the study on July 11, 2023 (approval number: NCKU HREC-E-111-563-2).

Author Biographies

Po-Ching Huang is a postdoctoral fellow at Chang Gung University in Taoyuan, Taiwan. She earned her doctoral degree from the Institute of Allied Health Sciences at National Cheng Kung University in Tainan, Taiwan. Her research interests include social psychology, behavioral addictions, and health-promoting behaviors.

Femke Geusens is a postdoctoral fellow at Uppsala University, Sweden. She obtained her PhD at the Leuven School for Mass Communication Research (KU Leuven, Belgium) and remained affiliated with KU Leuven as a member of the Research Unit for Reproduction and Lifestyle for Healthier Families. As a postdoctoral researcher specializing in media psychology in a health context, her research focuses on health communication, media psychology, media effects, self-effects, substance use, maternal mental health, prevention, and intervention.

Hsing-Fen Tu is a postdoctoral researcher at Uppsala University in Uppsala, Sweden. She completed her doctoral training at the Max Planck Institute for Human Cognitive and Brain Sciences and earned her Ph.D. in Medical Science from Leipzig University in Leipzig, Germany. Tu's research focuses on mental health, child development, and learning.

Xavier C. C. Fung is a PhD candidate at the Hong Kong Polytechnic University. His research focuses on the impact of weight stigma on emotions, weight management behaviors, and other psychosocial factors that interact with weight stigma, such as quality of life and problematic internet use.

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6. References

Alley, S., Wellens, P., Schoeppe, S., de Vries, H., Rebar, A. L., Short, C. E., Duncan, M. J., & Vandelanotte, C. (2017). Impact of increasing social media use on sitting time and body mass index. *Health Promotion Journal of Australia, 28*(2), 91-95. https://doi.org/10.1071/HE16026

Andreassen, C. S. (2015). Online social network site addiction: A comprehensive review. Current Addiction Reports, 2(2), 175-184. https://doi.org/10.1007/s40429-015-0056-9

Andreassen, C. S., Pallesen, S., & Griffiths, M. D. (2017). The relationship between addictive use of social media, narcissism, and self-esteem: Findings from a large national survey. Addictive Behaviors, 64, 287-293. https://doi.org/10.1080/13284207.2024.2341816

Ardesch, F. H., van der Vegt, D. D., & Kiefte-de Jong, J. C. (2023). Problematic social media use and lifestyle behaviors in adolescents: Cross-sectional questionnaire study. JMIR Pediatrics and Parenting, 6, e46966. https://doi.org/10.2196/46966

Arpaci, I., Baloglu, M., Ozteke Kozan, H. I., & Kesici, S. (2017). Individual differences in the relationship between attachment and nomophobia among college students: The mediating role of mindfulness. *Journal of Medical Internet Research, 19*(12), e404. https://doi.org/10.2196/jmir.8847

Ayar, D., Ozalp Gerceker, G., Ozdemir, E. Z., & Bektas, M. (2018). The effect of problematic internet use, social appearance anxiety, and social media use on nursing students' nomophobia levels. *Computers, Informatics, Nursing, 36*(12), 589-595. https://doi.org/10.1097/CIN.0000000000000458

Ball-Rokeach, S. J. (1998). A theory of media power and a theory of media use: Different stories, questions, and ways of thinking. *Mass Communication and Society, 1*(1-2), 5-40. https://doi.org/10.1080/15205436.1998.9676398

Bentler, P. M. (1990). Comparative fit indexes in structural models. *Psychological Bulletin, 107*(2), 238. https://doi.org/10.1037/0033-2909.107.2.238

Bevan, N., O'Brien, K. S., Latner, J. D., Lin, C. Y., Vandenberg, B., Jeanes, R., & Fung, X. C. C. (2022). Weight stigma and avoidance of physical activity and sport: Development of a scale and establishment of correlates. *International Journal of Environmental Research and Public Health, 19*(23), 16370. https://doi.org/10.3390/ijerph192316370

Blackwell, D., Leaman, C., Tramposch, R., Osborne, C., & Liss, M. (2017). Extraversion, neuroticism, attachment style and fear of missing out as predictors of social media use and addiction. *Personality and Individual Differences,* 116, 69-72. https://doi.org/10.1016/j.paid.2017.04.039

Chen, I. H., Ahorsu, D. K., Pakpour, A. H., Griffiths, M. D., Lin, C. Y., & Chen, C. Y. (2020). Psychometric properties of three simplified Chinese online-related addictive behavior instruments among mainland Chinese primary school students. Frontiers in Psychiatry, 11, 543419. https://doi.org/10.3389/fpsyt.2020.00875

Craig, C. L., Marshall, A. L., Sjöström, M., Bauman, A. E., Booth, M. L., Ainsworth, B. E., Pratt, M., Ekelund, U., Yngve, A., & Sallis, J. F. (2003). International Physical Activity Questionnaire: 12-country reliability and validity. *Medicine & Science in Sports & Exercise, 35*(8), 1381-1395. https://doi.org/10.1249/01.MSS.0000078924.61453.FB

Demircioğlu, G., & Genç, H. (2023). The effects of nomophobia on posture, anxiety, sleep quality, and physical activity in university students. *BAU Health and Innovation, 1*(1), 12-17. https://doi.org/10.14744/bauh.2023.54264

Deng, H. B., Macfarlane, D. J., Thomas, G. N., Lao, X. Q., Jiang, C. Q., Cheng, K. K., & Lam, T. H. (2008). Reliability and validity of the IPAQ-Chinese: The Guangzhou Biobank Cohort study. Medicine & Science in Sports & Exercise, 40(2), 303-307. https://doi.org/10.1249/mss.0b013e31815b0db5

Duijvestijn, M., de Wit, G. A., van Gils, P. F., & Wendel-Vos, G. C. W. (2023). Impact of physical activity on healthcare costs: A systematic review. *BMC Health Services Research, 23*(1), 572. https://doi.org/10.1186/s12913-023-09556-8

Fan, C. W., Chang, Y. L., Huang, P. C., Fung, X. C. C., Chen, J. K., Bevan, N., O'Brien, K. S., Yeh, Y. C., Chen, H. P., & Chen, I. H. (2023). The Tendency to Avoid Physical Activity and Sport Scale (TAPAS): Rasch analysis with differential item functioning testing among a Chinese sample. *BMC Psychology, 11*(1), 369. https://doi.org/10.1186/s40359-023-01377-y

Farris, S. G., Burr, E. K., Kibbey, M. M., Abrantes, A. M., & DiBello, A. M. (2020). Development and initial validation of the Exercise Sensitivity Questionnaire. Mental Health and Physical Activity, 19, 100346. https://doi.org/10.1016/j.mhpa.2020.100346

Gao, Y., Dai, H., Jia, G., Liang, C., Tong, T., Zhang, Z., Song, R., Wang, Q., & Zhu, Y. (2020). Translation of the Chinese version of the nomophobia questionnaire and its validation among college students: Factor analysis. *JMIR mHealth and uHealth, 8*(3), e13561. https://doi.org/10.2196/13561

Haseler, T., & Haseler, C. (2022). Lack of physical activity is a global problem. BMJ, 376, o348. https://doi.org/10.1136/bmj.o348

Horenstein, A., Kaplan, S. C., Butler, R. M., & Heimberg, R. G. (2021). Social anxiety moderates the relationship between body mass index and motivation to avoid exercise. Body Image, 36, 185-192. https://doi.org/10.1016/j.bodyim.2020.11.010

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*(1), 1-55. https://doi.org/10.1080/10705519909540118

Huang, P. C., Wu, H. C., Chen, J. K., Fung, X. C. C., Bevan, N., Ahorsu, D. K., Griffiths, M. D., Chen, J. S., Lee, K. H. L., Pakpour, A. H., & Lin, C. Y. (2024). The mediating role of physical activity avoidance in the association between weight stigma and physical activity. Mental Health and Physical Activity. (Under Review).

Huang, P. C., Chen, J. S., Potenza, M. N., Griffiths, M. D., Pakpour, A. H., Chen, J. K., Lin, Y. C., Hung, C. H., O'Brien, K. S., & Lin, C. Y. (2022). Temporal associations between physical activity and three types of problematic use of the internet: A six-month longitudinal study. *Journal of Behavioral Addictions, 11*(4), 1055-1067. https://doi.org/10.1556/2006.2022.00084

Huang, P. C., Latner, J. D., O'Brien, K. S., Chang, Y. L., Hung, C. H., Chen, J. S., Lee, K. H., & Lin, C. Y. (2023). Associations between social media addiction, psychological distress, and food addiction among Taiwanese university students. *Journal of Eating Disorders, 11*(1), 43. https://doi.org/10.1186/s40337-023-00769-0

IBM Corp. (2023). IBM SPSS Statistics for Windows, Version 29.0.2.0 Armonk, NY: IBM Corp

IPAQ Research Committee. (2005). Guidelines for data processing analysis of the International Physical Activity Questionnaire (IPAQ) - Short and long forms. https://drive.google.com/file/d/1gehdq1-04eSWfbxscwtzXa1MUlD8Mffa/view

Kagawa, F., Yokoyama, S., Takamura, M., Takagaki, K., Mitsuyama, Y., Shimizu, A., Jinnin, R., Ihara, H., Kurata, A., Okada, G., & Okamoto, Y. (2022). Decreased physical activity with subjective pleasure is associated with avoidance behaviors. *Scientific Reports 12*(1), 2832. https://doi.org/10.1038/s41598-022-06563-3

Khan, S., Atta, M., Malik, N. I., & Makhdoom, I. F. (2021). Prevalence and relationship of smartphone addiction, nomophobia, and social anxiety among college and university late adolescents. *Ilkogretim Online, 20*(5), 3588. https://doi.org/10.17051/ilkonline.2021.05.394

King, A. L., Valenca, A. M., & Nardi, A. E. (2010). Nomophobia: The mobile phone in panic disorder with agoraphobia: Reducing phobias or worsening of dependence? *Cognitive and Behavioral Neurology, 23*(1), 52-54. https://doi.org/10.1097/WNN.0b013e3181b7eabc

King, A. L. S., Valenca, A.-M., Silva, A.-C. O., Baczynski, T., Carvalho, M. R., & Nardi, A. E. (2013). Nomophobia: Dependency on virtual environments or social phobia? *Computers in Human Behavior, 29*(1), 140-144. https://doi.org/10.1016/j.chb.2012.07.025

Leung, H., Pakpour, A. H., Strong, C., Lin, Y. C., Tsai, M. C., Griffiths, M. D., Lin, C. Y., & Chen, I. H. (2020). Measurement invariance across young adults from Hong Kong and Taiwan among three internet-related addiction scales: Bergen social media addiction scale (BSMAS), smartphone application-based addiction scale (SABAS), and internet gaming disorder scale-short form (IGDS-SF9) (study Part A). Addictive Behaviors, 101, 105969. https://doi.org/10.1016/j.addbeh.2019.04.027

Lin, C. Y., Potenza, M. N., Ulander, M., Brostrom, A., Ohayon, M. M., Chattu, V. K., & Pakpour, A. H. (2021). Longitudinal relationships between nomophobia, addictive use of social media, and insomnia in adolescents. *Healthcare, 9*(9), 1201. https://doi.org/10.3390/healthcare9091201

Lin, Y. C., Chen, J. S., Bevan, N., O'Brien, K. S., Strong, C., Tsai, M. C., Fung, X. C. C., Chen, J. K., Lin, I. C., Latner, J. D., & Lin, C. Y. (2024). Chinese version of the Tendency to Avoid Physical Activity and Sport (TAPAS) scale: Testing unidimensionality, measurement invariance, concurrent validity, and known-group validity among Taiwanese youths. BMC Psychology, 12(1), 381. https://doi.org/10.1186/s40359-024-01870-y

Liu, W., Chen, J. S., Gan, W. Y., Poon, W. C., Tung, S. E. H., Lee, L. J., Xu, P., Chen, I. H., Griffiths, M. D., & Lin, C. Y. (2022). Associations of problematic internet use, weight-related self-stigma, and nomophobia with physical activity: Findings from Mainland China, Taiwan, and Malaysia. *International Journal of Environmental Research and Public Health, 19*(19), 12135. https://doi.org/10.3390/ijerph191912135

Macfarlane, D. J., Lee, C. C., Ho, E. Y., Chan, K. L., & Chan, D. T. (2007). Reliability and validity of the Chinese version of IPAQ (short, last 7 days). *Journal of Science and Medicine in Sport, 10*(1), 45-51. https://doi.org/10.1016/j.jsams.2006.05.003

Mason, J. E., & Asmundson, G. J. G. (2023). Cognitive behavioural techniques reduce exercise anxiety and improve adherence to a resistance training program for people with anxiety-related disorders: A randomized controlled trial. Journal of Anxiety Disorders, 95, 102693. https://doi.org/10.1016/j.janxdis.2023.102693

Mason, J. E., Faller, Y. N., LeBouthillier, D. M., & Asmundson, G. J. (2019). Exercise anxiety: A qualitative analysis of the barriers, facilitators, and psychological processes underlying exercise participation for people with anxiety-related disorders. Mental Health and Physical Activity, 16, 128-139. https://doi.org/10.1016/j.mhpa.2018.11.003

Newsom, J. T. (2023). Summary of Minimum Sample Size Recommendations. https://web.pdx.edu/~newsomj/semclass/ho_sample%20size.pdf

Ramachandran, K. M., & Tsokos, C. P. (2020). Mathematical statistics with applications in R. Academic Press.

Rosseel, Y. (2012). lavaan: An R package for structural equation modeling. Journal of Statistical Software, 48, 1-36. https://doi.org/10.18637/jss.v048.i02

Ruggiero, T. E. (2000). Uses and Gratifications theory in the 21st century. Mass Communication & Society, 3(1), 3-37. https://doi.org/10.1207/S15327825MCS0301_02

Saffari, M., Chen, I. H., Huang, P. C., O'brien, K. S., Hsieh, Y. P., Chen, J. K., Chang, Y. H., Jiang, X., Bevan, N., & Chang, Y. L. (2023). Measurement invariance and psychometric evaluation of the tendency to avoid physical activity and Sport Scale (TAPAS) among mainland Chinese university students. Psychology Research and Behavior Management, 16, 3821-3836. https://doi.org/10.2147/PRBM.S425804

Saffari, M., Huang, C. H., Huang, P. C., Chang, Y. H., Chen, J. S., Poon, W. C., Potenza, M. N., Griffiths, M. D., & Lin, C. Y. (2024). Mediating roles of weight stigma and physical activity avoidance in the associations between severity of gaming disorder and levels of physical activity in Taiwanese young adults. Journal of Behavioral Addictions. (Under review).

Shimoga, S. V., Erlyana, E., & Rebello, V. (2019). Associations of social media use with physical activity and sleep adequacy among adolescents: Cross-sectional survey. *Journal of Medical Internet Research, 21*(6), e14290. https://doi.org/10.2196/14290

The R Development Core Team. (2022). R: A language and environment for statistical computing. R Foundation for Statistical Computing. https://www.R-project.org/

Torlak, M. S., Gerçek, H., & Ünüvar, B. S. (2022). Relationship between physical activity and nomophobia in university students: A cross-sectional study. *Turkish Journal of Addictions, 9*(2), 176-181. https://doi.org/10.5152/ADDICTA.2022.22010

Wilcox, R. R. (2010). *Fundamentals of modern statistical methods: Substantially improving power and accuracy (Vol. 249).* Springer.

Wolf, E. J., Harrington, K. M., Clark, S. L., & Miller, M. W. (2013). Sample size requirements for structural equation models: An evaluation of power, bias, and solution propriety. *Educational and Psychological Measurement, 76*(6), 913-934. https://doi.org/10.1177/0013164413495237

Wong, Q. J. J., & Rapee, R. M. (2016). The aetiology and maintenance of social anxiety disorder: A synthesis of complimentary theoretical models and formulation of a new integrated model. Journal of Affective Disorders, 203, 84-100. https://doi.org/10.1016/j.jad.2016.05.069

World Health Organization. (2022). Physical activity. https://www.who.int/news-room/fact-sheets/detail/physical-activity

World Health Organization. (2020). WHO guidelines on physical activity and sedentary behaviour. https://www.who.int/publications/i/item/9789240015128

Yi, J., Chen, I. H., Chen, H. P., Lin, I. C., Chen, J. S., Huang, P. C., O'Brien, K. S., Griffiths, M. D., & Lin, C. Y. (2024). Tendency to avoid physical activity mediates the association between perceived weight stigma and physical activity levels among university students. Mental Health and Physical Activity, 26, 100584. https://doi.org/10.1016/j.mhpa.2024.100584

Yildirim, C., & Correia, A.-P. (2015). Exploring the dimensions of nomophobia: Development and validation of a self-reported questionnaire. Computers in Human Behavior, 49, 130-137. https://doi.org/10.1016/j.chb.2015.02.059

Yılmaz, D. A., Dege, G., & Çağıran, İ. H. (2023). The association between physical activity levels and social media addiction among adolescents: A descriptive correlational study. *Turkish Journal of Sport and Exercise, 25*(3), 499-507. https://doi.org/10.15314/tsed.1318092