

Mediating Roles of Psychological Distress, Insomnia, and Body Image Concerns in the Association Between Medical Exercise Addiction and Eating Disorders

Daniel Kwasi Ahorsu¹, Vida Imani², Marc N Potenza³, Hsin-Pao Chen^{4,5}, Chung-Ying Lin⁶, Amir H Pakpour^{7,8}

¹Department of Rehabilitation Sciences, Faculty of Health and Social Sciences, The Hong Kong Polytechnic University, Hung Hom, Hong Kong; ²Pediatric Health Research Center, Tabriz University of Medical Sciences, Tabriz, 5166/15731, Iran; ³Department of Psychiatry, Yale School of Medicine, New Haven, CT, USA; ⁴Division of Colon and Rectal Surgery, Department of Surgery, E-DA Hospital, I-Shou University, School of Medicine, Kaohsiung, Taiwan; ⁵College of Medicine, I-Shou University, Kaohsiung, 824, Taiwan; ⁶Institute of Allied Health Sciences, College of Medicine, National Cheng Kung University, Tainan, Taiwan; ⁷Social Determinants of Health Research Center, Research Institute for Prevention of Non-Communicable Diseases, Qazvin University of Medical Sciences, Qazvin, Iran; ⁸Department of Nursing, School of Health and Welfare, Jönköping University, Jönköping, Sweden

Correspondence: Amir H Pakpour; Hsin-Pao Chen, Email amir.pakpour@ju.se; shinpao2002@yahoo.com.tw

Purpose: Exercising can promote good health. However, excessive exercising may have downsides. This study examined the association between exercise addiction and eating disorders and whether the identified association was mediated by psychological distress, insomnia (including sleep quality), and body image concern.

Methods: A total of 2088 adolescents (mean age of 15.3 years) participated in this cross-sectional study by questions assessing exercise addiction, eating disorders, psychological distress, insomnia, sleep quality, and body image concern.

Results: There were significantly positive relationships between the variables ($r=0.12-0.54$, $p<0.01$) with effect sizes from small to large. The four potential mediators (ie, insomnia, sleep quality, psychological distress, and body image concern), individually and in total, significantly mediated the association between exercise addiction and eating disorders.

Conclusion: The findings suggest that exercise addiction in adolescents may influence eating disorders through multiple pathways, such as insomnia, psychological distress, and body image concerns. Future research should examine these relationships longitudinally and use gathered information to inform intervention development. Clinicians and healthcare workers are encouraged to assess exercise addiction when treating individuals with eating disorders.

Keywords: addictive behaviour, exercise, eating disorder, insomnia, stress, compulsive behaviour, adolescent

Introduction

Exercising often has beneficial effects on physical and mental health and quality of life. However, over-exercising may impair these domains. Experts have proposed four levels of exercising which include recreational, at-risk, problematic, and addictive.¹ In these levels of exercise, the activities may lead to mood-altering effects, improve self-esteem, and relieve depression and anxiety through specific brain effects such as the release of catecholamines and endorphins.^{1,2} The problematic exercise phase is where exercise becomes the main focus in life, with negative consequences more prominent.^{1,3} The exercise-addiction phase involves exercising that leads to neglect of other significant responsibilities, leading to clinically significant or distressing impairment in one or more domains of functioning.^{1,4}

Exercise addiction often involves seven criteria:^{1,3,5,6} a need for increasing amounts of exercise (tolerance); the experiencing of negative effects after stopping exercising (withdrawal); difficulties reducing exercising (impaired control); difficulties adhering to planned routines (intentions); use of considerable time preparing for, engaging in, and

recovering from exercising (time); interference in other important areas of function (reduction in other activities); persistent exercising even though it creates or worsens problems (continuance). These mentioned criteria are similar to those for substance use disorders.^{1,3,5-9} The prevalence of exercise addiction is generally between 3% and 42%⁸⁻¹¹ and between 3% and 13% among adolescents.¹¹

Several studies have reported the co-occurrence of exercise addiction with other mental health disorders such as eating disorders and other addictions involving sex, amphetamines, cocaine or caffeine.^{1,12-14} Eating disorders, which include bulimia nervosa, anorexia nervosa, and binge-eating disorder, involve abnormal eating behaviours that significantly impair the functioning of the individual.⁵ The estimated prevalence of eating disorders ranges from 0.8% to 30%, depending on the threshold (ie, full or partial) and type among Iranians.^{15,16} Eating disorders have been associated with physical and mental health challenges such as body dissatisfaction, depression, and psychological distress.^{1,15-20} Like eating disorders, exercise addiction has been associated with psychological distress, depression, and emotional stress.^{1,21,22} These findings suggest that exercise addiction and eating disorders may share characteristics such as being behavioural addictions and having similar health consequences.^{1,5,6} These relationships may be, in part, explained by the proposed biological mechanisms (eg, stimulation of dopaminergic brain structures) that connect mood to exercise.^{1,2,23,24}

In addition, there have been reported associations between exercise addiction and body image concerns (eg, body dysmorphic disorder).²⁵⁻²⁸ Although there have been reported associations between psychological distress (eg, depression, stress and anxiety) and insomnia (including sleep quality),^{17,19,20,29-31} potential associations between exercise addiction and insomnia are arguably less well studied. Sleep problems or insomnia as possible withdrawal symptoms have been reported when people with exercise addiction withhold or suspend exercising temporarily.^{32,33} Sleep and exercise have complex bilateral interactions such that one influences the other.³⁴ The intensity, duration, time of day, and/or environment of exercising may influence sleep, and conversely, sleep disturbances may influence the capacity to exercise.³⁴ Similarly, psychological distress is associated with exercise/inactivity and eating disorders.³⁵⁻³⁷ Furthermore, COVID-19 and its prevention policies such as quarantining and physical distancing have been linked to the worsening of mental health conditions.^{35,36,38-41}

Among adolescents, there have been significant associations between exercise addiction, eating disorders (eg, bulimia nervosa), psychological distress, and body dissatisfaction⁴²⁻⁴⁵ indicating that adolescents face these challenges as well. There is no known study among adolescents on variables mediating the associations between exercise addiction and eating disorders, although body image concerns or body shape mediated the association between bulimia nervosa/eating disorder and exercise addiction in previous studies among adults.^{27,46} It will, therefore, be important to know whether analogous relationships exist in adolescents and the directions of the relationships.

Exercising is healthy but over-engagement may be detrimental to health.¹⁻⁶ This may specifically apply to adolescents as they may be overly concerned about their body image which may have a cascading influence on their eating behaviours, sleep and psychological health.⁴²⁻⁴⁵ This paper, therefore, seeks to examine the mediating roles of psychological distress, insomnia, and body image concern in the association between exercise addiction and eating disorders among adolescents. Specifically, the study examines (1) the relationships between psychological distress, insomnia, body image concern, exercise addiction, and eating disorders, and (2) the mediating roles of psychological distress, insomnia, and body image concern in the association between exercise addiction and eating disorders. The research questions emanating from the objectives were: (1) would there be significant relationships between the study's variables and (2) would psychological distress, insomnia, and body image concern mediate an association between exercise addiction and eating disorders?

The present study's findings should help researchers and clinicians understand the mechanisms between these variables and more specifically how exercise addiction may influence eating disorders.

Methods

Participant and Procedure

Participants of the present study were adolescents from all high schools in Qazvin, Iran. This population was chosen due to limited empirical information on the mechanism underlying the association between exercise addiction and eating

disorders among them despite ample literature indicating a high prevalence of these concerns.^{1,15–20,27,42–46} Therefore, adolescents were eligible to be included (otherwise excluded) in the study if they (1) were aged between 13 to 18 years (2) were studying in a high school in Qazvin, and (3) provided a signed assent and consent form by themselves and one of their parents. The adolescents were recruited using a two-stage cluster sampling strategy. In the first stage, 15 high schools were randomly selected from all high schools in Qazvin City. Second, formal permission was sought from the heads of the 15 high schools. Third, the study aims were introduced to all interested adolescents in the 15 schools. They were guaranteed anonymity, confidentiality, and, if desired, withdrawal from the study anytime without repercussions. The questionnaire was then distributed for them to complete using a traditional paper-and-pencil method. There was a 69.6% response rate. Taking into consideration the effect size (small), alpha level (0.05), power (0.80), number of tested predictors (5), and total number of predictors (10), the least required sample size for the present study was 647.⁴⁷ The study was approved by both the Ethics Committee of Qazvin University of Medical Sciences and the Organization for Education at Qazvin.

Measures

Demographics

The demographics section solicited socio-demographic information from participants which included sex (ie, male or female), age (in years), parents' educational levels (in years), height (in meters), and weight (in kg).

Depression, Anxiety, and Stress Scale-21 (DASS-21)

The DASS-21⁴⁸ assessed participants' psychological distress levels using 21 items, with seven items each for depression, anxiety, and stress. Each question is responded to using a four-point Likert-like scale which ranges from “did not apply to me at all” (0 points) to “applied to me very much or most of the time” (3 points). The total psychological distress score was attained by the summation of all the 21-item responses made by a participant. Hence, the psychological distress score ranged between 0 and 63. Higher scores reflect higher levels of psychological distress. A sample item includes, “I felt that life was meaningless”. This scale has been used among Iranians and has acceptable psychometric properties.^{44,49}

Exercise Addiction Inventory - Youth Version (EAI-Y)

The EAI-Y, developed by Lichtenstein et al⁵⁰ and similar to the original version,⁵¹ assessed exercise addiction. The EAI-Y comprises six items that are each rated on a five-point Likert-like scale ranging from “strongly disagree” (1 point) to “strongly agree” (5 points). The total exercise-addiction score was obtained by summing the six-item responses. Hence, the exercise addiction score ranged between 6 and 30. Higher scores reflect higher levels of exercise addiction. A sample item includes, “Exercise is the most important thing in my life”. This scale has been used among Iranians and has acceptable psychometric properties.⁵²

Insomnia Severity Index (ISI)

The ISI⁵³ assessed insomnia severity. The ISI comprises seven items, each rated on a five-point Likert-like scale ranging from “no problem” (0 points) to “very severe problem” (4 points). All seven item responses were summed to get the total ISI score. Hence, the total ISI score ranged between 0 and 28. Higher scores reflect higher levels of insomnia. A sample item includes, “Difficulty falling asleep”. This scale has been used among Iranians and has acceptable psychometric properties.^{44,54}

Pittsburgh Sleep Quality Index (PSQI)

The PSQI⁵⁵ assessed sleep quality and disturbances. The PSQI comprises 19 items and seven component scores. The PSQI questions are each rated on a four-point Likert-like scale ranging from “not during the past month” (0 points) to “three or more times a week” (3 points). These item responses were added to form the global sleep quality and disturbances. Hence, the global sleep quality and disturbances scores ranged between 0 and 21. Higher PSQI scores reflect poorer quality of sleep. A sample item includes, “During the past month, how would you rate your sleep quality overall?”. This scale has been used among Iranians and has acceptable psychometric properties.^{56,57}

Body Image Concern Inventory (BICI)

The BICI⁵⁸ assessed body dysmorphic concern. The BICI comprises 19 items factoring into two domains: i) dysmorphic appearance concern (12 items) and ii) interference in social functioning due to appearance concerns (seven items). The BICI items use a five-point Likert-like scale ranging from “Never” (1 point) to “Always” (5 points). The total BICI score was acquired by adding the 19-item responses. Hence, BICI scores ranged from 19 to 95, with higher scores reflecting higher levels of dysmorphic concern. A sample item includes, “I am dissatisfied with some aspect of my appearance”. This scale has been used among Iranians and has acceptable psychometric properties.⁵⁹

Eating Attitudes Test - 26 Item (EAT-26)

The EAT-26, developed by Garner et al,⁶⁰ assessed eating attitudes and behaviours. The EAT-26 comprises 26 items, with each rated on a six-point Likert-like scale ranging from “Never” (0 points) to “Always” (5 points), or on a four-point Likert-like scale ranging from “Never” (0 points) to “Always” (3 points). Hence, the total score from adding all items together ranged between 0 and 78. Higher scores reflect higher levels of eating disturbances. A sample item includes, “Am terrified about being overweight”. This scale has been used among Iranians and has acceptable psychometric properties.^{44,61}

Statistical Analysis

Means, standard deviations (SD), frequency (n), and percentages (%) were used to describe participant characteristics. Pearson’s correlations were used to examine relationships between psychological distress, exercise addiction, insomnia, body image concern, and eating disorders. The effect sizes for the correlations were small ($r=0.10$), medium ($r=0.30$), and large ($r=0.50$).⁶² The mediational analysis was conducted with the use of Hayes’ Model 4 and 5000 bootstrapping resamples via PROCESS macro for SPSS.⁶³ In the mediational model, psychological distress, insomnia, and body image concern were the mediating variables, exercise addiction was the independent variable and eating disorder was the dependent variable. Age, sex, adolescents’ BMI, and mothers’ and fathers’ years of education were included in the model as covariates. Moreover, all potential mediators (ie, psychological distress, insomnia, and body image concerns) were entered into the mediational model simultaneously. Therefore, the mediation model performed in the present study is a multivariate analysis. All p-values less than 0.05 were considered statistically significant.

Results

Table 1 indicates that the participants had an average age of 15.3 (SD = 3.7) years. Of the 2088 participants, 989 (47.4%) were male, and participants’ fathers and mothers had 9.8 (SD = 4.1) and 7.4 (SD = 3.9) years of education, respectively. Few participants reported smoking tobacco (176, 8.4%). The average BMI was 21.1 (SD = 4.8) kg/m².

Table 2 shows Pearson’s correlation matrix between psychological distress, exercise addiction, insomnia, sleep quality, body image concerns, and eating disorders. Their correlation coefficients were all significant and ranged between

Table 1 Characteristics of the Study Participants (N=2088)

	Mean±SD or n (%)
Age (in years)	15.3±3.7
Sex	
Males	989 (47.4)
Females	1099 (52.6)
Fathers’ years of education	9.8±4.1
Mothers’ years of education	7.4±3.9
BMI (kg/m ²)	21.1±5.3
Currently smoking (Yes)	176 (8.4%)
Psychological distress ^a	24.1±8.9

(Continued)

Table 1 (Continued).

	Mean±SD or n (%)
Exercise addiction ^b	16.9±5.6
Insomnia ^c	9.6±3.4
Sleep quality ^d	7.3±2.4
Body image concern ^e	49.3±16.7
Eating disorder ^f	25.2±10.6

Notes: ^aMeasured using Depression, Anxiety, and Stress Scale-21 (DASS-21). ^bMeasured using the Exercise Addiction Inventory youth version (EAI-Y). ^cMeasured using the Insomnia Severity Index (ISI). ^dMeasured using the Pittsburgh Sleep Quality Index (PSQI). ^eMeasured using the Body Image Concern Inventory (BICI). ^fMeasured using the Eating Attitudes Test - 26 Item (EAT-26).

Table 2 Pearson Correlation Matrix of the Variables of Interest

	1	2	3	4	5	6
1. Psychological distress ^a	1	0.35	0.48	0.49	0.54	0.41
2. Exercise addiction ^b		1	0.15	0.12	0.30	0.17
3. Insomnia ^c			1	0.45	0.40	0.31
4. Sleep quality ^d				1	0.46	0.35
5. Body image concern ^e					1	0.38
6. Eating disorder ^f						1

Notes: All p-values < 0.01. ^aMeasured using Depression, Anxiety, and Stress Scale-21 (DASS-21). ^bMeasured using the Exercise Addiction Inventory youth version (EAI-Y). ^cMeasured using the Insomnia Severity Index (ISI). ^dMeasured using the Pittsburgh Sleep Quality Index (PSQI). ^eMeasured using the Body Image Concern Inventory (BICI). ^fMeasured using the Eating Attitudes Test - 26 Item (EAT-26).

0.12 and 0.54 (p-values < 0.01). That is, there were significantly positive relationships between psychological distress, exercise addiction, insomnia, sleep quality, body image concerns, and eating disorders which ranged from small to large effect size ($r = 0.12-0.54$, $p < 0.01$).

Table 3 shows the results of the mediational analysis that examined the mediating roles of psychological distress, insomnia, sleep quality, and body image concern in the association between exercise addiction and eating disorders. In all, there was a significant total effect of exercise addiction on eating disorders (unstandardized coefficient = 0.23, $t =$

Table 3 Models of the Effect of Adolescents' Exercise Addiction on Eating Disorder with Mediators of Insomnia, Sleep Quality, Psychological Distress and Body Image Concern

	Unstand. Coeff.	SE or (Bootstrapping SE)	t-value or (Bootstrapping LLCI)	p-value or (Bootstrapping ULCI)
Total effect of exercise addiction on eating disorder	0.234	0.030	7.706	0.001
Direct effect of exercise addiction on eating disorder 5th	0.096	0.028	3.440	0.001
Direct effect of exercise addiction on mediators				
Psychological distress 2nd	0.382	0.055	6.934	<0.001
Insomnia 3rd	0.189	0.028	6.741	<0.001
Sleep quality 4th	0.131	0.024	5.356	<0.001
Body image concerns 1st	0.859	0.076	11.252	<0.001

(Continued)

Table 3 (Continued).

	Unstand. Coeff.	SE or (Bootstrapping SE)	t-value or (Bootstrapping LLCI)	p-value or (Bootstrapping ULCI)
Indirect effect of EAI-Y on eating disorder				
Total indirect effect	0.139	(0.020)	(0.099)	(0.178)
Through psychological distress 2nd	0.036	(0.010)	(0.019)	(0.056)
Through insomnia 3rd	0.031	(0.008)	(0.017)	(0.047)
Through sleep quality 4th	0.019	(0.006)	(0.008)	(0.032)
Through body image concern 1st	0.053	(0.011)	(0.032)	(0.076)
Indirect effect comparisons				
Psychological distress vs body image concern	-0.017	(0.015)	(-0.045)	(0.012)
Insomnia vs body image concern	-0.021	(0.012)	(-0.046)	(0.003)
Sleep quality vs body image concern	-0.034	(0.012)	(-0.059)	(-0.010)
Psychological distress vs insomnia	0.005	(0.012)	(-0.019)	(0.028)
Psychological distress vs sleep quality	0.017	(0.011)	(-0.004)	(0.040)
Insomnia vs sleep quality	0.012	(0.009)	(-0.004)	(0.030)

Notes: Age, gender, adolescents' BMI, mothers' and fathers' years of education were adjusted for the model. 1st, 2nd, 3rd, 4th, and 5th represent the ranks in which exercise addiction is associated with the other variables.

Abbreviations: Unstand. Coeff., unstandardized coefficient; LLCI, lower limit in 95% confidence interval; ULCI, upper limit in 95% confidence interval.

7.71, $p = 0.001$). Likewise, there were significantly direct effects of exercise addiction on body image concerns (unstandardized coefficient = 0.86, $t = 11.25$, $p < 0.001$), psychological distress (unstandardized coefficient = 0.38, $t = 6.93$, $p < 0.001$), insomnia (unstandardized coefficient = 0.19, $t = 6.74$, $p < 0.001$), sleep quality (unstandardized coefficient = 0.13, $t = 5.36$, $p < 0.001$), and eating disorders (unstandardized coefficient = 0.10, $t = 3.44$, $p = 0.001$). Furthermore, it was found that body image concerns (unstandardized coefficient = 0.05, LLCI = 0.03, ULCI = 0.08), psychological distress (unstandardized coefficient = 0.04, LLCI = 0.10, ULCI = 0.18), insomnia (unstandardized coefficient = 0.03, LLCI = 0.02, ULCI = 0.05), and sleep quality (unstandardized coefficient = 0.02, LLCI = 0.01, ULCI = 0.03) were significant mediators in the association between exercise addiction and eating disorders. Indirect effect comparisons of the mediators revealed that all were non-significant except the comparison between body image concerns and sleep quality (unstandardized coefficient = -0.03, LLCI = -0.06, ULCI = -0.01).

Figure 1 further presents the pictorial view of the mediation model. All paths were found to be statistically significant.

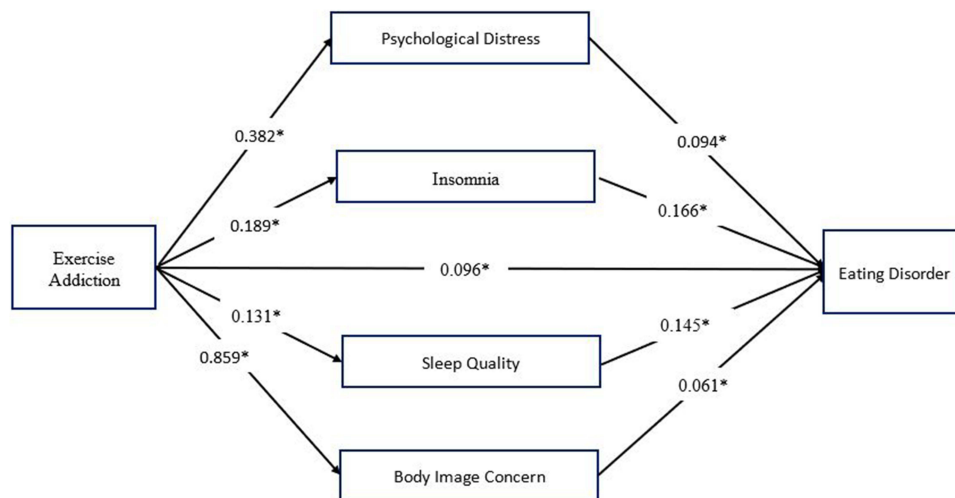


Figure 1 Mediation model with psychological distress, insomnia, sleep quality, and body image concern as mediators of the association between exercise addiction and eating disorders. * $P < 0.05$.

Discussion

This novel study examined mediating roles of psychological distress, insomnia, and body image concern in the association between exercise addiction and eating disorders. The findings indicated that there were significantly positive relationships between exercise addiction, psychological distress, insomnia, body image concern, and eating disorders with small to large effect sizes. Therefore, higher levels of psychological distress may lead to higher levels of body image concerns, insomnia, exercise addiction, and eating disorders with a strong relationship between psychological distress, insomnia, and body image concerns, a moderate relationship between psychological distress, and eating disorder, and a small relationship between psychological distress and exercise addiction. Hence, all other things being equal, these findings suggest a possible mechanism for how exercise addiction may relate to eating disorders through mental health concerns (ie, psychological distress, insomnia, and body image concerns). These findings are consistent with previous studies which have examined the relationships between exercise addiction and psychological distress^{21,22} and exercise addiction and body image concerns^{25–28} and other relationships (eg, between exercise addiction and insomnia).^{42–44} That is, it has been consistently revealed through several previous studies that there are significantly positive relationships between these variables irrespective of age and conditions (healthy or ill) of participants.^{21,22,25–28,42–44} These significant relationships also served as the basis for the mediation analyses.

In addition, the mediational analyses revealed that insomnia, psychological distress, and body image concerns individually and in total mediated the association between exercise addiction and eating disorders. That is, apart from exercise addiction directly influencing eating disorders, it was also observed that exercise addiction influenced eating disorders through each one of these mediating variables. Specifically, exercise addiction indirectly influenced eating disorders through either insomnia, psychological distress, or body image concerns, further indicating that insomnia, psychological distress, and body image concerns (individually) have roles among people with exercise addiction having eating disorders. Furthermore, all variables directly influenced eating disorders. These findings resonate with prior reports regarding correlations among these variables.^{21,22,25–28,42–44} Furthermore, it suggests that there are several ways in which exercise addiction may influence eating disorders. Hence, clinicians and healthcare workers should consider these relationships when helping individuals during treatment. Specifically, clinicians and healthcare workers should be conscious of other psychological factors such as insomnia, psychological distress, and body image concerns that may further worsen their condition or complicate the treatment. Future longitudinal studies will be important to replicate and extend these findings via testing the relationships over time. The current study identified possible mediating variables (eg, body image concerns or body shape) between exercise addiction and eating disorders.^{27,46} Moreover, inter-mediator comparisons revealed that there were no differences between the mediators in influencing the association between exercise addiction and eating disorders except between body image concern and sleep quality. The findings suggest that body image concern has a stronger mediating effect compared to sleep quality, which suggests that body image concern have the tendency of influencing eating disorder more. Therefore, extra care and resources may be needed for individuals with body image concerns compared to sleep quality concerns. Furthermore, the current findings confirm that the directionality of the association between exercise addiction and eating disorders does not affect their mediating variables.^{27,46}

This current study has some limitations and so caution should be exercised in interpreting the findings. First, participants were adolescent high-school students in Iran; thus, the findings may not extend to other age groups, jurisdictions or populations. Future studies may consider adult or general populations. Second, a cross-sectional design was used which limits the ability to draw causal inferences (or there is a lack of assessment of causality sequences between exercise addiction and eating disorders). Therefore, longitudinal studies are needed. Third, data were collected using a questionnaire which may be prone to biases such as social desirability response bias and cultural influence (eg, collectivism).^{64,65} Fourth, individual types of eating disorders were not assessed. This may be considered in future studies. Furthermore, researchers may consider replicating this study among people with eating disorders and exercise addiction so as to compare the findings as participants in this study were “normal” adolescents (ie, without known predisposition or observed psychopathology). Fifth, there was no chronotype assessment which would have enriched our findings and discussion, especially with respect to exercise addiction as there is an

established association between chronotypes, mood and eating disorders.^{66,67} Future studies may consider the role of chronotypes in these associations.

Conclusions

This novel study revealed that there were significantly positive relationships between exercise addiction, psychological distress, insomnia, body image concerns, and eating disorders with small to large effect sizes. Furthermore, the four mediators (ie, insomnia, psychological distress, and body image concern), individually and in total, mediated the association between exercise addiction and eating disorders. This suggests that there may be several ways by which exercise addiction may influence eating disorders. Future research is needed to translate this information into empirically validated interventions. Also, researchers may consider using a longitudinal design and/or adult populations to help consider possible causal relationships among the variables and generalization, respectively.

Compliance with Ethical Standards

All the methods were performed in accordance with the Declaration of Helsinki. The study was approved by the Ethical Committee of Qazvin University of medical sciences (protocol code IR.QUMS.REC.1401.098). Informed consent was obtained from one of the parents of adolescents and adolescents themselves who participated in the study.

Acknowledgments

We would also like to thank study participants and their parents.

Funding

This study was funded by the Qazvin University of Medical Sciences (1401). Hsin-Pao Chen is financially supported by the funding of the E-Da Hospital (EDAPH111043 & EDACHT111007).

Disclosure

Dr. Potenza has consulted for Opiant Therapeutics, Game Day Data, Baria-Tek, the Addiction Policy Forum, AXA, and Idorsia Pharmaceuticals; been involved in a patent application with Yale University and Novartis; received research support from Mohegan Sun Casino, Children and Screens and the Connecticut Council on Problem Gambling; participated in surveys, mailings, or telephone consultations related to drug addictions, internet use, impulse-control disorders, and other health topics; consulted for or advised gambling, non-profit and legal entities on issues related to internet use, impulse-control and /addictive disorders; and given academic lectures in grand rounds, continuing medical education events, and other clinical or scientific venues. The authors report no other conflicts of interest in this work.

References

1. Freimuth M, Moniz S, Kim SR. Clarifying exercise addiction: differential diagnosis, co-occurring disorders, and phases of addiction. *Int J Environ Res Public Health*. 2011;8:4069–4081. doi:10.3390/ijerph8104069
2. Griffiths M. Exercise addiction: a case study. *Addict Res*. 1997;5:161–168. doi:10.3109/16066359709005257
3. Johnston O, Reilly J, Kremer J. Excessive exercise: from quantitative categorisation to a qualitative continuum approach. *Eur Eat Disord Rev*. 2011;19:237–248. doi:10.1002/erv.970
4. Landolfi E. Exercise addiction. *Sports Med*. 2013;43:111–119. doi:10.1007/s40279-012-0013-x
5. American Psychiatric Association, D.S.M.T.F. *Diagnostic and Statistical Manual of Mental Disorders: DSM-5*. 5th ed. Arlington, VA: American Psychiatric Association; 2013.
6. American Psychiatric Association, D.S.M.T.F. *Diagnostic and Statistical Manual of Mental Disorders: DSM-IV-TR*. 4th ed. Washington, DC: American Psychiatric Association; 2000.
7. Veale D. *Does Primary Exercise Dependence Really Exist?* Leicester: British Psychological Society; 1995:71–75.
8. Lichtenstein MB, Melin AK, Szabo A, Holm L. The prevalence of exercise addiction symptoms in a sample of national level elite athletes. *Front Sports Act Living*. 2021;3:635418. doi:10.3389/fspor.2021.635418
9. Griffiths MD. A ‘components’ model of addiction within a biopsychosocial framework. *J Subst Use*. 2005;10:191–197. doi:10.1080/14659890500114359
10. Di Lodovico L, Poulhais S, Gorwood P. Which sports are more at risk of physical exercise addiction: a systematic review. *Addict Behav*. 2019;93:257–262. doi:10.1016/j.addbeh.2018.12.030

11. Marques A, Peralta M, Sarmento H, Loureiro V, Gouveia ER, Gaspar de Matos M. Prevalence of risk for exercise dependence: a systematic review. *Sports Med.* 2019;49:319–330. doi:10.1007/s40279-018-1011-4
12. Carnes PJ, Murray RE, Charpentier L. Bargains with chaos: sex addicts and addiction interaction disorder. *Sex Addict Compulsivity.* 2005;12:79–120. doi:10.1080/10720160500201371
13. Haylett SA, Stephenson GM, Lefever RMH. Covariation in addictive behaviours: a study of addictive orientations using the shorter PROMIS questionnaire. *Addict Behav.* 2004;29:61–71. doi:10.1016/S0306-4603(03)00083-2
14. Sussman S, Lisha N, Griffiths M. Prevalence of the addictions: a problem of the majority or the minority? *Eval Health Prof.* 2010;34:3–56. doi:10.1177/0163278710380124
15. Nobakht M, Dezhkam M. An epidemiological study of eating disorders in Iran. *Int J Eat Disord.* 2000;28:265–271. doi:10.1002/1098-108X(200011)28:3<265::AID-EAT3>3.0.CO;2-L
16. Garrusi B, Baneshi MR. Eating disorders and their associated risk factors among Iranian population - a community based study. *Glob J Health Sci.* 2012;5:193–202. doi:10.5539/gjhs.v5n1p193
17. Tavolacci M-P, Ladner J, Dechelotte P. COVID-19 pandemic and eating disorders among university students. *Nutrients.* 2021;13:4294. doi:10.3390/nu13124294
18. Suwalska J, Kolasińska K, Łojko D, Bogdański P. Eating behaviors, depressive symptoms and lifestyle in university students in Poland. *Nutrients.* 2022;14:1106. doi:10.3390/nu14051106
19. Clemente-Suárez VJ, Martínez-González MB, Benitez-Agudelo JC, et al. The impact of the COVID-19 pandemic on mental disorders. A critical review. *Int J Environ Res Public Health.* 2021;18:10041. doi:10.3390/ijerph181910041
20. Kundu S, Rejwana N, Al Banna MH, et al. Linking depressive and anxiety symptoms with diet quality of university students: a cross-sectional study during the COVID-19 pandemic in India. *Healthcare.* 2022;10:1848. doi:10.3390/healthcare10101848
21. Colledge F, Buchner U, Schmidt A, et al. Individuals at risk of exercise addiction have higher scores for depression, ADHD, and childhood trauma. *Front Sports Act Living.* 2022;3:761844. doi:10.3389/fspor.2021.761844
22. Lichtenstein MB, Nielsen RO, Gudex C, Hinze CJ, Jørgensen U. Exercise addiction is associated with emotional distress in injured and non-injured regular exercisers. *Addict Behav Rep.* 2018;8:33–39. doi:10.1016/j.abrep.2018.06.001
23. Craft LL, Perna FM. The benefits of exercise for the clinically depressed. *Prim Care Companion J Clin Psychiatry.* 2004;6:104–111. doi:10.4088/pcc.v06n0301
24. Adams J. Understanding exercise dependence. *J Contemp Psychother.* 2009;39:231. doi:10.1007/s10879-009-9117-5
25. Corazza O, Simonato P, Demetrovics Z, et al. The emergence of exercise addiction, body dysmorphic disorder, and other image-related psychopathological correlates in fitness settings: a cross sectional study. *PLoS One.* 2019;14:e0213060–e0213060. doi:10.1371/journal.pone.0213060
26. Gori A, Topino E, Pucci C, Griffiths MD. The relationship between alexithymia, dysmorphic concern, and exercise addiction: the moderating effect of self-esteem. *J Pers Med.* 2021;11:1111. doi:10.3390/jpm11111111
27. Gori A, Topino E, Griffiths MD. Protective and risk factors in exercise addiction: a series of moderated mediation analyses. *Int J Environ Res Public Health.* 2021;18:9706. doi:10.3390/ijerph18189706
28. Babalou A, Salehian MH. Relationship between body image concern and dysfunctional attitudes in predicting exercise addiction among bodybuilders. *Sci J Rehabil Med.* 2019;8:231–240. doi:10.22037/jrm.2019.111409.1971
29. Lu M-Y, Ahorsu DK, Kureti S, et al. The prevalence of post-traumatic stress disorder symptoms, sleep problems, and psychological distress among COVID-19 frontline healthcare workers in Taiwan. *Front Psychiatry.* 2021;12:705657. doi:10.3389/fpsyt.2021.705657
30. Fazeli S, Mohammadi Zeidi I, Lin C-Y, et al. Depression, anxiety, and stress mediate the associations between internet gaming disorder, insomnia, and quality of life during the COVID-19 outbreak. *Addict Behav Rep.* 2020;12:100307. doi:10.1016/j.abrep.2020.100307
31. Ahorsu DK, Lin C-Y, Pakpour AH. The association between health status and insomnia, mental health, and preventive behaviors: the mediating role of fear of COVID-19. *Gerontol Geriatr Med.* 2020;6:2333721420966081. doi:10.1177/2333721420966081
32. Morris M, Steinberg H, Sykes EA, Salmon P. Effects of temporary withdrawal from regular running. *J Psychosom Res.* 1990;34:493–500. doi:10.1016/0022-3999(90)90023-W
33. Aidman EV, Woollard S. The influence of self-reported exercise addiction on acute emotional and physiological responses to brief exercise deprivation. *Psychol Sport Exerc.* 2003;4:225–236. doi:10.1016/S1469-0292(02)00003-1
34. Chennaoui M, Arnal PJ, Sauvet F, Léger D. Sleep and exercise: a reciprocal issue? *Sleep Med Rev.* 2015;20:59–72. doi:10.1016/j.smr.2014.06.008
35. Chirico A, Lucidi F, Galli F, et al. COVID-19 outbreak and physical activity in the Italian population: a cross-sectional analysis of the underlying psychosocial mechanisms. *Front Psychol.* 2020;11:2100. doi:10.3389/fpsyg.2020.02100
36. Galli F, Giancamilli F, Palombi T, et al. Anxiety, motives, and intention for physical activity during the Italian COVID-19 lock-down: an observational longitudinal study. *Int J Environ Res Public Health.* 2022;19:4689. doi:10.3390/ijerph19084689
37. Zhang L, Xie Y, Li B, Weng F, Zhang F, Xia J. Psychiatric symptoms and frequency of eating out among commuters in Beijing: a bidirectional association? *Nutrients.* 2022;14:4221. doi:10.3390/nu14204221
38. Tran TK, Dinh H, Nguyen H, et al. The impact of the COVID-19 pandemic on college students: an online survey. *Sustainability.* 2021;13:10762. doi:10.3390/su131910762
39. Petrovič F, Murgaš F, Králik R. Happiness in Czechia during the COVID-19 pandemic. *Sustainability.* 2021;13:10826. doi:10.3390/su131910826
40. Shirali G, Rahimi Z, Araban M, Mohammadi M, Cheraghian B. Social-distancing compliance among pedestrians in ahvaz, south-west Iran during the covid-19 pandemic. *Asian J Soc Health Behav.* 2021;4(4):131–136. doi:10.4103/shb.shb_74_21
41. Alijanzadeh M, Ahorsu DK, Alimoradi Z, et al. Fear of COVID-19 and trust in the healthcare system mediates the association between individual's risk perception and preventive COVID-19 behaviours among Iranians. *Int J Environ Res Public Health.* 2021;18:12146. doi:10.3390/ijerph182212146
42. Levallius J, Collin C, Birgegård A. Now you see it, now you don't: compulsive exercise in adolescents with an eating disorder. *J Eat Disord.* 2017;5:9. doi:10.1186/s40337-016-0129-8
43. Formby P, Watson HJ, Hilyard A, Martin K, Egan SJ. Psychometric properties of the Compulsive Exercise Test in an adolescent eating disorder population. *Eat Behav.* 2014;15:555–557. doi:10.1016/j.eatbeh.2014.08.013

44. Lin C-Y, Cheung P, Imani V, Griffiths MD, Pakpour AH. The mediating effects of eating disorder, food addiction, and insomnia in the association between psychological distress and being overweight among Iranian adolescents. *Nutrients*. 2020;12:1371. doi:10.3390/nu12051371
45. Ahorsu DK, Lin C-Y, Imani V, et al. A prospective study on the link between weight-related self-stigma and binge eating: role of food addiction and psychological distress. *Int J Eat Disord*. 2020;53:442–450. doi:10.1002/eat.23219
46. Levit M, Weinstein A, Weinstein Y, Tzur-Bitan D, Weinstein A. A study on the relationship between exercise addiction, abnormal eating attitudes, anxiety and depression among athletes in Israel. *J Behav Addict*. 2018;7:800–805. doi:10.1556/2006.7.2018.83
47. Faul F, Erdfelder E, Lang A-G, Buchner A. G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behav Res Methods*. 2007;39:175–191. doi:10.3758/BF03193146
48. Lovibond PF, Lovibond SH. The structure of negative emotional states: comparison of the Depression Anxiety Stress Scales (DASS) with the Beck Depression and Anxiety Inventories. *Behav Res Ther*. 1995;33:335–343. doi:10.1016/0005-7967(94)00075-U
49. Asghari A, Saed F, Dibajnia P. Psychometric properties of the Depression Anxiety Stress Scales-21 (DASS-21) in a non-clinical Iranian sample. *Int J Psychol*. 2008;2:82–102.
50. Lichtenstein MB, Griffiths MD, Hemmingsen SD, Støving RK. Exercise addiction in adolescents and emerging adults – validation of a youth version of the Exercise Addiction Inventory. *J Behav Addict*. 2018;7:117–125. doi:10.1556/2006.7.2018.01
51. Terry A, Szabo A, Griffiths M. The exercise addiction inventory: a new brief screening tool. *Addict Res Theory*. 2004;12:489–499. doi:10.1080/16066350310001637363
52. Akbari M, Zamani E, Seydavi M, Griffiths MD, Pakpour AH. The Persian exercise addiction inventory—adult and youth versions: psychometric properties based on rasch analysis among Iranians. *Int J Ment Health Addict*. 2022. doi:10.1007/s11469-022-00797-y
53. Bastien CH, Vallières A, Morin CM. Validation of the Insomnia Severity Index as an outcome measure for insomnia research. *Sleep Med*. 2001;2:297–307. doi:10.1016/S1389-9457(00)00065-4
54. Yazdi Z, Sadeghniai-Haghighi K, Zohal MA, Elmizadeh K. Validity and reliability of the Iranian version of the insomnia severity index. *Malays J Med Sci*. 2012;19:31–36.
55. Buysse DJ, Reynolds CF, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatry Res*. 1989;28:193–213. doi:10.1016/0165-1781(89)90047-4
56. Farrahi Moghaddam J, Nakhaee N, Sheibani V, Garrusi B, Amirkafi A. Reliability and validity of the Persian version of the Pittsburgh Sleep Quality Index (PSQI-P). *Sleep Breath*. 2012;16:79–82. doi:10.1007/s11325-010-0478-5
57. Chehri A, Brand S, Goldaste N, et al. Psychometric properties of the Persian Pittsburgh Sleep Quality Index for adolescents. *Int J Environ Res Public Health*. 2020;17:7095. doi:10.3390/ijerph17197095
58. Littleton HL, Axsom D, Pury CLS. Development of the body image concern inventory. *Behav Res Ther*. 2005;43:229–241. doi:10.1016/j.brat.2003.12.006
59. Ghadakzadeh S, Ghazipour A, Khajeddin N, Karimian N, Borhani M. Body Image Concern Inventory (BICI) for identifying patients with BDD seeking rhinoplasty: using a Persian (Farsi) version. *Aesthetic Plast Surg*. 2011;35:989–994. doi:10.1007/s00266-011-9718-8
60. Garner DM, Olmsted MP, Bohr Y, Garfinkel PE. The Eating Attitudes Test: psychometric features and clinical correlates. *Psychol Med*. 1982;12:871–878. doi:10.1017/S0033291700049163
61. Ahmadi S, Moloodi R, Zarbakhsh M-R, Ghaderi A. Psychometric properties of the eating attitude test-26 for female Iranian students. *Eat Weight Disord*. 2014;19:183–189. doi:10.1007/s40519-014-0106-7
62. Cohen JA. Power primer. *Psychol Bull*. 1992;112:155–159. doi:10.1037/0033-2909.112.1.155
63. Hayes AF. *Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-Based Approach*. 2nd ed. New York: Guilford Publications; 2018.
64. Latkin CA, Edwards C, Davey-Rothwell MA, Tobin KE. The relationship between social desirability bias and self-reports of health, substance use, and social network factors among urban substance users in Baltimore, Maryland. *Addict Behav*. 2017;73:133–136. doi:10.1016/j.addbeh.2017.05.005
65. Krumpal I. Determinants of social desirability bias in sensitive surveys: a literature review. *Qual Quant*. 2013;47(4):2025–2047. doi:10.1007/s11135-011-9640-9
66. Rodríguez-Cortés FJ, Morales-Cané I, Rodríguez-Muñoz PM, et al. Individual circadian preference, eating disorders and obesity in children and adolescents: a dangerous liaison? A systematic review and a meta-analysis. *Children*. 2022;9:167. doi:10.3390/children9020167
67. Plano SA, Soneira S, Tortello C, Golombek DA. Is the binge-eating disorder a circadian disorder? *Front Nutr*. 2022;9:964491. doi:10.3389/fnut.2022.964491

Psychology Research and Behavior Management

Dovepress

Publish your work in this journal

Psychology Research and Behavior Management is an international, peer-reviewed, open access journal focusing on the science of psychology and its application in behavior management to develop improved outcomes in the clinical, educational, sports and business arenas. Specific topics covered in the journal include: Neuroscience, memory and decision making; Behavior modification and management; Clinical applications; Business and sports performance management; Social and developmental studies; Animal studies. The manuscript management system is completely online and includes a very quick and fair peer-review system, which is all easy to use. Visit <http://www.dovepress.com/testimonials.php> to read real quotes from published authors.

Submit your manuscript here: <https://www.dovepress.com/psychology-research-and-behavior-management-journal>