Tun J Sport Sci Med 2023; 1(1):8-19

10.61838/kman.tjssm.1.1.3

Tunisian Journal of Sports Science and Medicine

Original Research

Exploring Physical Activity's Role in Mitigating Nomophobia Among Tunisian University Students: A Comprehensive Analysis Using the Arabic DASS-12 with Path Modeling

Oumaima Mechraoui[1], Hilmi Jelleli[2], Feten Fekih-Romdhane[3, 4], Mahmoud Rebhi[2, 10*], Mouna Saidane[5], Noomen Guelmami[2, 5], Mohamed Ben Aissa[2], Walid Chater[2], Tore Bonsaken[6, 7], Ismail Dergaa[2, 8, 9, 10]

[1] Interdisciplinary Laboratory in Neurosciences, Physiology and Psychology: Physical Activity, Health and Learning, UFR STAPS, UPL, Paris Nanterre University, Paris, France
[2] Department of Human and Social Sciences, Higher Institute of Sport and Physical Education of Kef, University of Jendouba, Jendouba, Tunisia
[3] Tunis El Manar University, Faculty of Medicine of Tunis, Tunis, Tunisia
[4] Department of Psychiatry “Ibn Omrane”, Razi Hospital, Manouba, Tunis, Tunisia
[5] High Institute of Sport and Physical Education of Sfax, University of Sfax, Sfax 3000
[6] Department of Health and Nursing Science, Faculty of Social and Health Sciences, Inland Norway University of Applied Sciences, 2418 Elverum, Norway
[7] Department of Health, Faculty of Health Studies, VID Specialized University, 4024 Stavanger, Norway
[8] Primary Health Care Corporation (PHCC), Doha, Qatar
[9] Research Unit Physical Activity, Sport, and Health, UR18JS01, National Observatory of Sport, Tunis 1003, Tunisia
[10] High Institute of Sport and Physical Education, University of Sfax, Sfax, Tunisia

*** Corresponding author email address**: rebhimahmoud@gmail.com; mahmoudrebhi@issepsf.u-sfax.tn

Received: 2023-12-07 **Reviewed:** 2023-12-22 **Revised:** 2023-12-25 **Accepted:** 2023-12-26 **Published:** 2023-12-29

Abstract

Background: Due to their stage of life and the daily stressors they encounter, students are particularly susceptible to both behavioral and psychological issues. Our study was designed with two objectives in mind: (1) to evaluate the reliability and validity of the Arabic version of the Depression, Anxiety, and Stress Scales (DASS-12) in Arabic and (2) to explore the potential mitigating effect of physical activity on the relationship between nomophobia and distress in students.

Methods: A cross-sectional analysis was undertaken with a sample of Tunisian students who regularly use smartphones (N=533, 64.6% female, mean age 22.05±2.76 years).

Results: The exploratory and confirmatory factor analyses pointed to the DASS-12 as a secondary 3-factor scale. The internal consistency of the scale, as measured by Cronbach’s alphas, was 0.98 for stress, 0.90 for anxiety, and 0.84 for depression. The results of the measurement model supported the suitability and reliability of all the DASS-12 items in capturing the underlying constructs. Structural model analysis revealed positive correlations between physical activity and nomophobia with stress, anxiety, and depression. Moreover, physical activity was found to moderate the relationship between nomophobia and two elements of distress: stress and anxiety.

Conclusion: The findings of this study open up novel intervention strategies for students grappling with nomophobia. In particular, the results suggest that promoting physical activity might serve as a coping strategy to counteract the impacts of nomophobia on stress and anxiety symptoms in students.

Keywords: *Physical Activity, Nomophobia, Tunisian University Students, DASS-12, Path Modeling*

How to cite this article:

Mecheraoui O, Jelleli H, Fekih-Romdhane F, Rebhi M, Saidane M, Guelmami N, Ben Aissa M, Chater W, Bonsaken T, Dergaa I. Exploring Physical Activity's Role in Mitigating Nomophobia Among Tunisian University Students: A Comprehensive Analysis Using the Arabic DASS-12 with Path Modeling. *Tun J Sport Sci Med*. 2023;1(1):8-19.

1. Introduction

Our daily lives have become increasingly reliant on mobile phones. “Nomophobia” (No Mobile Phone phobia) is a term that essentially describes a psychological condition where people fear being detached from their smartphone. This phobia creates an irrational fear in the individuals who become restless when they cannot access to their phones (1). Nomophobia is considered a frequent and emerging problem among university students worldwide (2), and has potential negative impact on their mental health and well-being (2-5). Some studies have shown potential association between nomophobia and negative mental health (anxiety, stress and depression) (6, 7). For instance, Tolan and Karahan (6), discovered a positive association between university students’ levels of nomophobia and their levels of depression, anxiety, and stress, implying that nomophobia was related to poorer mental health. Similarly, studies from Lebanon and Saudi Arabia have found positive correlations between nomophobia and psychological conditions, i.e., a substantial link between high levels of anxiety and a higher probability of having severe nomophobia (4, 7). With technology continuing to influence most aspects of people's life, nomophobia leads to people being increasingly present physically but absent psychologically; and might therefore be the next “epidemic” (8). Because of the potential negative impact of nomophobia on mental health, the nature and moderators of the association between nomophobia and distress measures is an essential topic to research in order to develop preventative measures and possible therapies. One of the possible moderators in this relationship is physical activity.

Physical activity has been demonstrated to be consistently and inversely associated with distress indicators in university students (9, 10) . A cross-sectional study based on data from the Spanish National Health Survey 2017 involving 4195 participants showed that physical activity levels were linked to depression, anxiety and other mental health problems in Spanish youth (11). In a recent study, changes in physical activity levels were found to have a substantial inverse relationship with the degree of depression, stress, and post-traumatic stress. Reductions in moderate-to-vigorous physical activity time were found to be a risk factor for mild stress and moderate-to-severe depression, whereas increasing moderate-to-vigorous physical activity frequency was found to be a protective factor for mild and moderate-to-severe depressive symptoms (12). Other studies, however, foundweak correlations between these three variables (13), and a recent study showed no association between anxiety, depression and physical activity levels (13). On the other hand, more severe nomophobia has been shown to contribute to decreased physical activity (14-16). For example, Bichu and Kumar (15) found a negative correlation between nomophobia and levels of physical activity in young adults. This conclusion was also supported by the work of Halil Tan (16), in which a weak-level relationship between physical activity and the risk of omophobia was found. However, another study among Saudi E-sports players showed no significant association between nomophobia and physical activity (7).

Overall, a growing but still limited body of empirical research has shown increased physical activity to have a favorable effect on mental health and a negative association with nomophobia (15, 17, 18). However, shortcomings of previous investigations have been noted, among them the missed opportunity of considering physical activity as a moderator variable between nomophobia and relevant mental health measures. Investigating the pathways leading from nomophobia to distress through physical activity, particularly in the vulnerable student population, will be an addition to and an enforcement of ongoing prevention and intervention efforts to support students’ mental health. In this regard, the first objective of the present study was to examine the psychometric properties of the DASS-12 measurement instrument in terms of validity and reliability, since the tool has not been validated in our context.We sought, as a secondary objective, to investigate the moderating effect of physical exercise on the relationship between nomophobia and psychological distress among Tunisian university students.

2. Methods and Materials

2.1. Participants and procedure

From November 23, 2021, to 19 February 2022, a Google Forms poll was used to gather cross-sectional data. To acquire data from Tunisian students, we employed a snowball sampling strategy among Tunisian student Facebook users. This strategy is increasingly used in social network investigations (19). Participants completed an informed consent form using a particular Google Gmail account. Then they asked their friends to do the poll. This process allows to construct a customized ballot box to govern numerous replies. We utilized Google's Cloud Computing infrastructure, which allows each user to submit one and only one survey response. However, this method needs a Google email account and restricts access to users' IP addresses for concerns of privacy and security. The research fulfilled the “CHERRIES” Recommended Standards for Online Surveys (20).

The research was authorized by the Tunisian Institute of Sport and Physical Education and was undertaken in accordance with the ethical standards of the Declaration of Helsinki (1964, 2013) and its subsequent amendments.

Informed consent was presented to the participants, and they were assured that their responses to the Google Forms survey would remain anonymous.

The inclusion criteria were: (1) Being a Tunisian resident, Arabic-speaking university student, (2) being aged 18 and over, (3) having permanent internet access and being consistent smartphone users to retain a relatively uniform social and cultural setting, non-residents of Tunisia were excluded from the research.

According to Weber et al. (21), Tunisia has 6.5 million Facebook members. For this online survey, we utilized Raosoft's sample size calculator and formulae. Similar previous research proposed a minimum sample size of 395, given a 66% response rate, 5% accuracy or margin of error, and 50% proportion with a 95% confidence interval.

Smartphone users were polled (n=533). After removing the surveys with outlets cases (n=38), 495 responses were retained. Participants were mostly females (n=320, 64.6%), and had an average age of 22.05±2.76 years.

2.2. Measures

2.2.1. The Nomophobia questionnaire (NMP-Q)

The Nomophobia Questionnaire (NMP-Q) is a 20-item 7-point Likert scale, with item scores ranging from 1 to 7, 1 indicating "strongly disagree" and 7 indicating "strongly agree." It is applied to each NMP-Q item, generating a total score. The NMP-Q score is converted into a nomophobia level (total score ranging between 20 and 140), with 20 indicating no nomophobia, 21–59 indicating a mild degree, 60–99 indicating a moderate level, and 100 or above indicating a severe level (22). The scale was first was composed of four factors: inability to communicate (F1=ITC), loss of connectedness (F2=LOC); inability to acquire information (F3=ITAI) and giving up convenience (F4=GC) (22). In this study, the pre-existing Arabic version of the scale was used (23). This measure had a good Cronbach's alpha (= 0.948).

2.2.2. The DASS-12 Questionnaire

The DASS-12 represents a shortened version of DASS-21 (24), and was used to evaluate stress, anxiety and depression. The degree to which respondents endorse the symptoms over the course of the last week is rated on a scale ranging from 0 (did not apply to me at all) to 3 (applied to me very much or most of the time). Higher scores reflect higher levels of symptom endorsement. The DASS-12 has previously shown good reliability and validity across studies (25). The Arabic version of the scale was used in this study.

2.2.3. The Arabic short version of the International Physical Activity Questionnaire

To assess physical activity, we used a short Arabic version of the IPAQ scale (www.ipaq.ki.se). The tool provides MET-min per week for three types of physical activity (walking, moderate-intensity activity, and vigorous-intensity activity), and the scores were calculated as follows: walking = (3.3 × walking minutes × walking days); moderate activity = (4.0 × moderate activity minutes × moderate activity days); vigorous activity = (8.0 × vigorous activity minutes × vigorous activity days). Sufficient vigorous activity was established if the participant reported 3 or more days of vigorous-intensity activity of at least 20 min per day. Similarly, sufficient moderate and walking activities were established if the participant reported 5 or more days of moderate-intensity and walking of at least 30 min per day. Physical activity levels were also classified into three categories: inactive, minimally active and health-enhancing physically active, according to the scoring system provided by IPAQ (www.ipaq.ki.se) (26). This IPAQ has established good psychometric properties in several populations, including the Arabic population (27).

2.2.4. Statistical analysis

Skewness and kurtosis tests were used to explore data normality, whereas multivariate normality was assessed in the confirmatory phase. Asymmetry and kurtosis values above 7 were considered non-Gaussian and indicative of poor psychometric sensitivity. The Mardia coefficient was used to examine multivariate normality.

The unweighted least squares method with direct Oblimin rotation was used for DASS-12 exploratory factor analysis. Before factors extractiobn, the polychoric correlation matrix was analyzed. The sample adequacy was assessed using the Kaiser-Meyer-Olkin (KMO) statistic (28).

Barkley and Lepp (29) stated that the KMO value must be bigger than 0.50 to accept the factorial solution. The chi-square value of the Bartlett sphericity test was also computed. The factors were kept for eigenvalues > 1 and by examining the scree plot. Also, items with factor loading less than 0.5 on the proposed factor were eliminated.

We conducted a confirmatory factor analysis (CFA) with the maximum likelihood (ML) method to establish the Model parameters. The CFA Goodness-of fit was evaluated using a range of model fit indices. Model assessment included Chi-square, Chi-Square/DDL Adjusted goodness-of-fit index (AGFI), goodness-of-fit index (GFI), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR) (30). Because large samples impact the chi-square fit statistic, the ratio of the chi-square statistic to the degrees of freedom $\chi 2/df$ is preferable.

For GFI and AGFI, Hu and Bentler (31) recommended a critical value of 0.90 or higher to accept the model. CFI and TLI have a threshold value of 0.95 and higher. Moreover, SRMR > 0.08 and RMSEA > 0.08 suggests a reasonable fit. The RMSEA 90%CI was included. AIC was also used for model comparison, with lower values indicating better fit.

The internal consistency of the DASS-12 was evaluated using the Cronbach´s α coefficient and corrected for item-total correlations. Cronbach´s α > 0.8, and item-total and inter-item correlations >0.4 were considered appropriate.

Descriptive statistical analyses of the factor structure of DASS-12 were performed with SPSS for Windows, version 26 (IBM Corp), and Amos software for Windows, version 23 (IBM Corp). The pre-processed data were then loaded into SmartPLS 3 (v. 3.3.7), a premier program for Structural Equation Modelling based on Partial Least Square Data analysis (PLS-SEM). This study used second generation statistical and soft computing modelling approaches available in the program to establish and analyze modelled pathways. The first data processing in SmartPLS 3 was to build the conceptual model shown in Figure 2. This was the path model of hypothesized associations between the included variables. The path model was then assessed using two methods: measurement model and structural model evaluations. The program assesses both models concurrently.

3. Results

3.1. Validity and reliability of DASS-12

3.1.1. Exploratory factor analysis

Before exploiting the exploratory factor analysis, we checked the kurtosis and skewness coefficient to exam the normality. All items kurtosis and Skewness coefficients was Gaussian with values lower than 2 and 1, respectively. While, the Mardia's kurtosis coefficient was 14.62 confirming multivariate normality. The results of KMO (=0.92) and Bartlett’s Test of Sphericity ($\chi 2$=2.71; df=66; P<0.001) supported the factorability of DASS12 data. As seen in Table 1, Exploratory factor analysis indicated a three-factor solution (eigenvalues were 6.15, 1.73, and 1.03 for the first, second, and third factor, respectively), explaining 74.21% of the total variance.

The first component explained 51.28% of the overall variance, the second factor explained 51.28 % of the variance, the second 14.38%, and the final factor explained 8.56 % of the variance (see Table 1).

Table 1. Initial Eigenvalues, % of variance and factors patterns of DASS-12 Exploratory Factor analysis

Items	Initial Eigenvalues	% of variance	Factor patterns		
			1	2	3
AN3	6.15	51.28	0.87		
AN2			0.84		
AN1			0.81		
AN4			0.79		
ST2	1.73	14.38		0.85	
ST4				0.85	
ST3				0.83	
ST1				0.77	
DP4	1.03	8.56			0.88
DP1					0.75
DP3					0.71
DP2					0.63

Note. DASS: Depression, Anxiety and Stress Scales.

Note. ST items 1-4 are stress items, AN 1-4 are anxiety items, and DP 1-4 are depression items.

3.1.2. Internal reliability

Cronbach's alpha was used to assess the three scale variables' internal consistency. The indices for all three scale components were 0.89 for stress, 0.90 for anxiety and 0.84 for depression. Each latent variable's adjusted item-total correlation was also computed, and the results are shown in Table 2. The values were appropriate.

Table 2. Internal consistency of DASS-12

Items	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Cronbach's Alpha
ST1	4.96	5.21	0.76	0.87	0.89
ST2	4.94	5.04	0.78	0.87	
ST3	4.93	5.08	0.78	0.87	
ST4	4.89	4.84	0.78	0.87	
AN1	3.96	5.69	0.77	0.88	0.90
AN2	4.00	5.78	0.79	0.87	
AN3	4.08	5.66	0.79	0.87	
AN4	3.96	5.99	0.78	0.87	
DP1	1.80	2.09	0.68	0.80	0.84
DP2	1.77	2.14	0.62	0.82	
DP3	1.78	2.04	0.68	0.80	
DP4	1.81	2.06	0.73	0.78	

ST items 1-4 are stress items, AN 1-4 are anxiety items, and DP 1-4 are depression items.

3.1.3. Confirmatory factor analysis

The chi-square value found in the CFA was 76.8 (P<.001). The values of GFI and AGFI were 0.975 and 0.962, respectively. In addition, the two indices TLI and CFI gravitated toward 1, and thus, respected the threshold value of 0.95. Finally, the error indices—RMSEA=0.032 (90 percent CI 0-0.04) and SRMR=0.014—showed that the measurement errors were reasonable (see Figure 1).

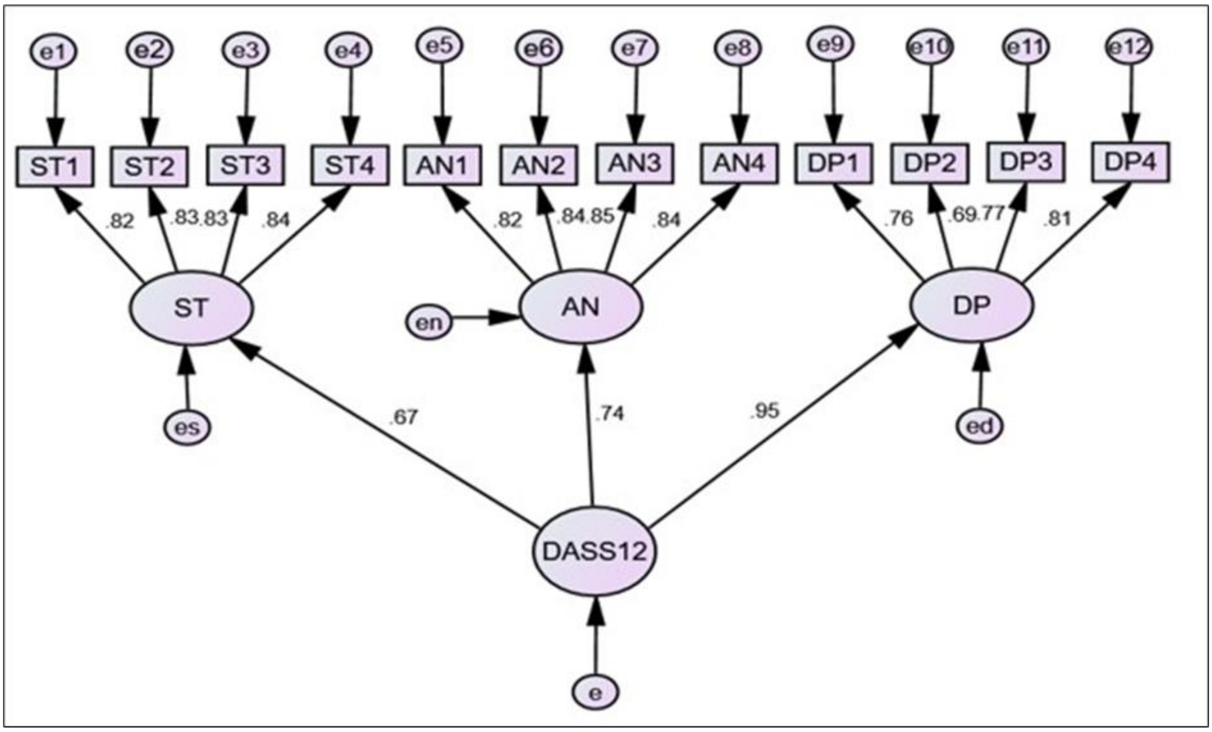

Figure 1. Confirmatory factor analysis of DASS12

3.1.4. Smartpls Model

The result of the PLS algorithm for moderation analysis is presented in Figure 2.

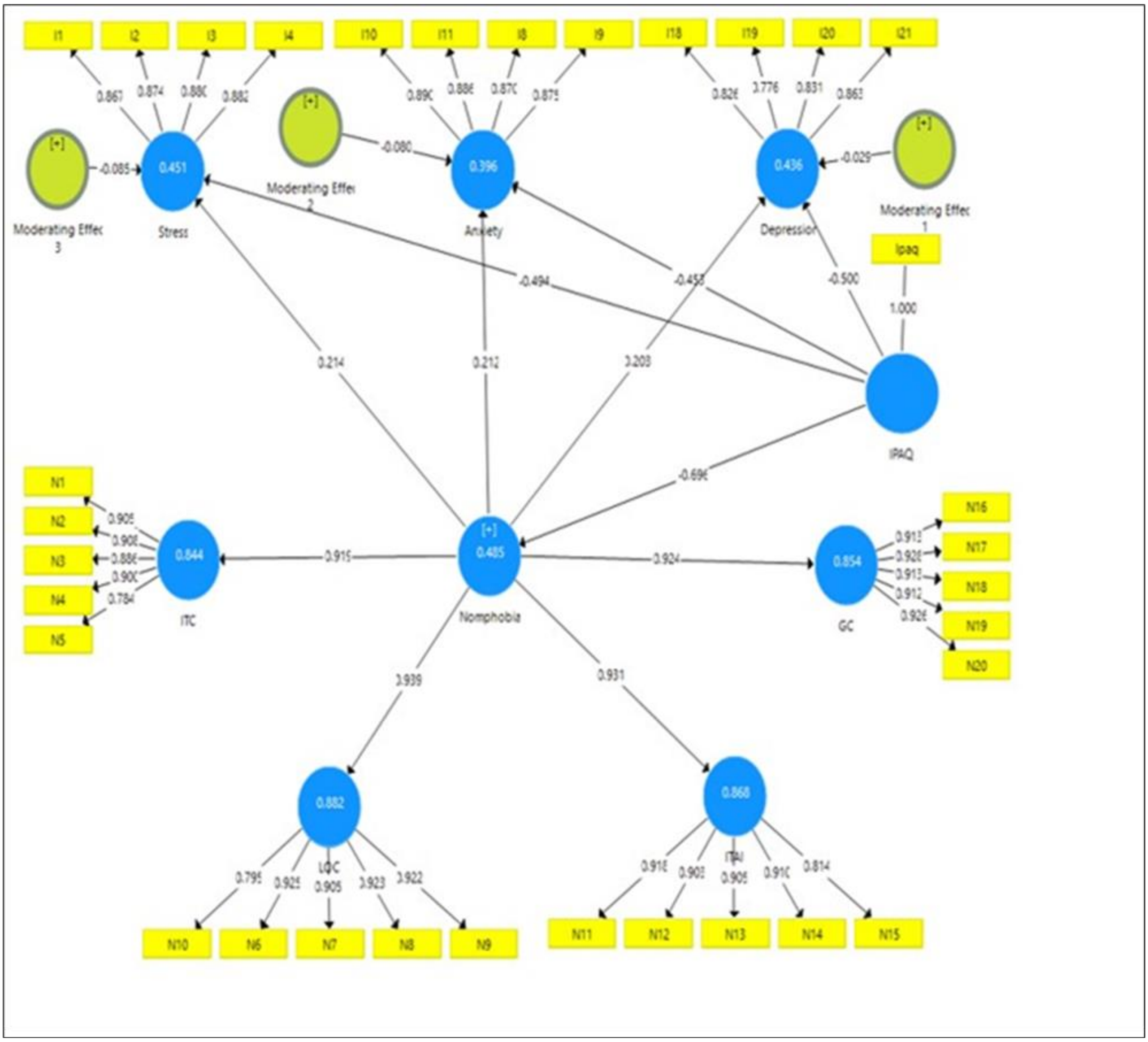

Figure 2. The Smart PLS model

3.1.5. Reliability and Convergent Validity

In a SmartPLS model, we may assess construct reliability using three coefficients: Cronbach's alpha, Joreskog's composite reliability (CR), and Dijkstra-Rho-A. Henseler's A reliability coefficient that lies between Cronbach's alpha and composite reliability. It has a suggested threshold of 0.70 for measuring dependability (28).

The Cronabach's alpha reliability coefficient must be better than 0.6 to pass the internal consistency examination. The Joreskog Rho composite dependability index must be 0.7 (28). All indexes are reliable. Convergent validity describes how well indicators measure the constructs they are designed to measure, i.e., how well a measure correlates with another measure of the same construct. PLS examines a measure's convergent validity by evaluating the mean variance extracted (AVE) (32).

The AVE is the mean variance of a concept and its measurements. It is the total of the squared loads of all indicators linked with a construct (divided by the number of indicators) (32).

Convergent validity is confirmed if a concept and its measurements share more variance than other latent variables in the same model. AVE fewer than 0.50 suggests that the indicators have more mistakes than the constructs' average variance explained. As a result, an AVE value of 0.50 or above is acceptable (32).

Table 3 shows that all AVE values are over the acceptable threshold of 0.5, confirming convergent validity.

Table 3. Reliability and convergent validity of latent variables

	Cronbach's Alpha	Rho_A	Composite Reliability	Average Variance Extracted (AVE)
Anxiety	0.903	0.906	0.932	0.775
Depression	0.843	0.846	0.895	0.68
Nomphobia	0.976	0.976	0.978	0.685
Stress	0.899	0.899	0.929	0.767
ITC	0.951	0.951	0.962	0.835
LOC	0.959	0.959	0.968	0.86
ITAI	0.952	0.952	0.963	0.838
GC	0.954	0.954	0.964	0.844

Note. ITC: inability to communicate; LOC: loss of connectedness; ITAI: inability to acquire information; GC: giving up convenience.

3.1.6. Discriminant validity

The discriminant validity examines if a construct's stated phenomena is unique and not reflected by other latent variables in the model (32).

The Fornel-Larcker criteria and Heterotrait-Monotrait Ratio of correlation was used to measure discriminant validity (HTMT). To be discriminant, a construct's loadings must be high on itself and low on others (33). Its second discriminant validity may be verified by comparing its square root to latent variable correlations (34). The correlation matrix shows the square roots of the AVE coefficients. The square root of each construct's AVE must exceed its greatest association with the others (32).

Table 4 displays the Hetrotrait- Monotrait Ratio (HTMT) criteria, while the diagonal of Table 5 shows Forner Lacker Criterion and confirmed the discriminant validity of the model.

Table 4. Hetrotrait- Monotrait Ratio (HTMT)

	Anxiety	Depression	ITC	LOC	ITAI	GC	IPAQ	Nomophobia
Depression	0.71							
ITC	0.56	0.59						
LOC	0.55	0.57	0.77					
ITAI	0.46	0.50	0.76	0.79				
GC	0.56	0.58	0.78	0.82	0.80			
IPAQ	0.63	0.70	0.65	0.64	0.63	0.65		
Stress	0.50	0.64	0.58	0.59	0.54	0.55	0.68	0.62

Note. ITC: inability to communicate; LOC: loss of connectedness; ITAI: inability to acquire information; GC: giving up convenience; IPAQ: International Physical Activity Questionnaire.

Table 5. Forner Lacker Criterion

Factors	Anxiety	Depression	ITC	LOC	ITAI	GC	IPAQ	Nomophobia	Stress
Anxiety	0.88								
Depression	0.62	0.83							
ITC	0.52	0.53	0.91						
LOC	0.52	0.52	0.73	0.93					
ITAI	0.43	0.45	0.72	0.75	0.92				
GC	0.52	0.52	0.74	0.79	0.76	0.92			
IPAQ	-0.60	-0.64	-0.64	-0.62	-0.62	-0.64	1.00		
Nomophobia	0.55	0.56	0.89	0.91	0.90	0.91	-0.70	0.83	
Stress	0.45	0.56	0.54	0.55	0.50	0.51	-0.64	0.58	0.88

Note. ITC: inability to communicate; LOC: loss of connectedness; ITAI: inability to acquire information; GC: giving up convenience; IPAQ: International Physical Activity Questionnaire.

3.1.7. Structural Model

In PLS, the predictive capacity of a model or construct is determined by the standard path coefficient of each link between exogenous and endogenous variables. R^2 measures how much variation in construction is explained by the model. R^2 of 0.67 is considered large, 0.33 medium, and 0.19 poor by (35).

For effect size, we used Stone-Geisser's Q^2 value, which represents an evaluation criterion for the cross-validated predictive relevance effect size. Effect size criteria are as follows: small effect size 0.02, medium effect size 0.15, high effect size 0.35 (36).

Medium R^2 were found for Anxiety, Depression and Stress with 0.40 (Q^2=0.30), 0.44 (Q^2=0.29), and 0.45 (Q^2=0.34), respectively. 0.49 (Q^2=0.33) was demonstrated for nomophobia.

After testing the measurement model and the structural model, we ran a bootstrapping algorithm for testing hypotheses. The model confirmed that higher levels of physical activity are related to lower levels of anxiety, depression and stress. Moreover, the model showed that higher physical activity levels produce lower levels of nomophobia. Likewise, Nomophobia showed direct positive effects on Stress, Depression and Anxiety scores (see Table 6).

Table 6. Direct links hypothesis testing

	Mean (M)	Standard Deviation (STDEV)	T	P	Hypothesis
IPAQ -> Anxiety	-0.60	0.03	21.15	<0.001	Confirmed
IPAQ -> Depression	-0.64	0.03	25.59	<0.001	Confirmed
IPAQ -> Stress	-0.64	0.03	25.98	<0.001	Confirmed
IPAQ -> F1=ITC	-0.62	0.02	25.88	<0.001	Confirmed
IPAQ -> F2=LOC	-0.64	0.02	26.43	<0.001	Confirmed
IPAQ -> F3=ITAI	-0.63	0.02	26.40	<0.001	Confirmed
IPAQ -> F4=GC	-0.64	0.02	26.33	<0.001	Confirmed
Nomophobia -> Anxiety	0.22	0.04	5.08	<0.001	Confirmed
Nomophobia -> Depression	0.21	0.05	4.58	<0.001	Confirmed
Nomophobia -> Stress	0.22	0.05	4.28	<0.001	Confirmed

Note. ITC: inability to communicate; LOC: loss of connectedness; ITAI: inability to acquire information; GC: giving up convenience; IPAQ: International Physical Activity Questionnaire.

The analysis of Table 6 in the paper, focusing on the moderating effects of the International Physical Activity Questionnaire (IPAQ) on the relationships between nomophobia and depression, anxiety, and stress, reveals distinct outcomes. The hypothesis that physical activity moderates the relationship between nomophobia and depression is rejected, as indicated by a non-significant mean (-0.02) and a high p-value (0.52). In contrast, the hypotheses for anxiety and stress are confirmed, with both showing significant negative mean values (-0.08), low p-values (0.039 for anxiety and 0.038 for stress), and T-statistics above 2.0. This suggests that higher levels of physical activity are associated with lower levels of anxiety and stress in individuals with nomophobia, but no such moderating effect is observed for depression.

4. Discussion

The main objective of this study was to present a conceptual model to test the hypothesis that physical activity has a significant moderating role in the relationships between nomophobia and psychological distress (as indicated by levels of stress, anxiety and depression) among Tunisian university students. Also, the study sought to explore the psychometric qualities of the Arabic DASS-12 in our sample. The results of the measurement model confirmed that all DASS-12 items were adequate and reliable for measuring the latent psychological distress constructs, suggesting the appropriateness of the scale for use in Arabic-speaking individuals, at least in Tunisia. Also, the analysis of the structural model suggested that higher levels of physical activity and more nomophobia are positively associated with greater stress, anxiety and depression. Finally, our results showed that physical activity has a moderating effect on the associations between nomophobia and stress, as well as between nomophobia and anxiety.

As for the direct effect, our findings expand the existing knowledge by providing further support for the positive association between nomophobia and depression, anxiety and stress. In agreement with our results, Tolan and Karahan (6) and Kubrusly et al. (37) found a positive correlation between higher nomophobia scores and more severe depression, anxiety, and stress symptoms as assessed by the DASS scale among university students (6, 37). In many studies, nomophobia has been associated with both depression and stress (4, 38, 39). According to a systematic review and a meta-analysis conducted by Yang and co-workers (40), a significantly increased risk of depression and anxiety was prominent in people with nomophobia. Similar evidence was also found in a cross-sectional study involving 1386 high school students aged 14 to 17 years old. The study's results indicated that nomophobia is an emerging mental health condition, particularly among male adolescents, and it is significantly associated with depression, anxiety, and poor quality of life. Veerapu and co-workers (41) showed comparable conclusions in a study where nomophobia and anxiety were positively correlated. In a broader perspective, although not addressing the particular construct of nomophobia, previous research has emphasized the impact of problematic mobile phone use with symptoms of depression and anxiety (40). Similar patterns of associations between these variables have also been demonstrated in Arabic countries (4, 7, 42).

With regard to the indirect effect of physical activity on the association between nomophobia and distress, our hypothesis was partially confirmed, indicating that physical activity moderated this relationship only for the anxiety and stress dependent variables. These findings are clinically relevant and have important implications that we propose later in this paper. As expected, we found a negative association between IPAQ scores and anxiety, depression, and stress. Participants with higher levels of physical activity had lower levels of anxiety, depression, and stress. Previous research backs up our findings, indicating that physical activity is negatively associated with anxiety, depression, and stress (43). Meyer and co-workers (44) also found that during the COVID-19 lockdown, a reduction in physical activity was associated with higher negative mental health, lower positive mental health, and more severe anxiety and depression symptoms. Anxiety symptoms were more common in those who did not fulfil moderate – to – vigorous PA (MVPA) requirements, and the degree of anxiety symptoms was inversely related to weekly minutes of intense activity. During the fall 2020 COVID-19 shutdown in Spain, 2,250 middle-aged adults were found to have a similar link between physical activity and reported anxiety (45). Those who met WHO requirements for physical activity were roughly half as prone to anxiety (45). In addition, research showed that vigorous, but not moderate physical activity or walking, was negatively associated with stress; Weekly time spent in vigorous physical activity was negatively associated with stress independent of age, sex, and hours worked per week (46). Furthermore, the model of the present study showed direct effects of the four factors of nomophobia on IPAQ. This suggests that when students' nomophobia levels increase, their physical activity may decrease. Our findings are in line with previous reports of an association between physical activity and nomophobia, such as the work of Christofaro and co-workers (47). Similarly, Bichu and Kumar (15), suggested a negative correlation between nomophobia and level of physical activity in young adults. Also, Halil Tan (16) found a positive relationship between physical activity and the risk of nomophobia. This is, to our knowledge the first study that demonstrated the moderating role of physical activity in the relationship between nomophobia and distress. Although based on cross-sectional results, along with a limited evidence, the present findings suggest that exercise interventions may be considered as an alternative non-pharmacological approach for treating individuals with nomophobia (48).

5. Study limitations

This study has some limitations that should be discussed. First, due to its cross-sectional design, no causal conclusions can be drawn. Second, the self-report measures may lead to response and recall biases. Third, we only included university students, which limits the generalizability of our findings to other extended populations. Future research should seek to further explore nomophobia in nonstudent populations of different social and economic groups, and among different age and ethnicity groups. Finally, our study did not explore correlations between levels of nomophobia and other mental health indicators, such as students' personality, solitude behavior or time spent using the mobile phone. Hence, we recommend considering these factors in further investigations.

6. Study implications

Because of their age and the life stressors they face, university students are at heightened vulnerability to both behavioral and mental health problem. Therefore, helping students in overcoming behavioral addictions and their subsequent effects on mental health is necessary for educators, administrators, counselors and researchers.

By confirming the moderating effect of physical activity in the relationship between nomophobia and anxiety/stress, we offer new avenues for intervention in the vulnerable population of students. In other words, we suggest that increasing physical activity may help buffer the harmful effects of nomophobia on anxiety and stress symptoms among students. Several previous studies have identified physical activity as a possible intervention for reducing anxiety symptoms, especially among adolescents and young people (49, 50). Recent meta-analyses have demonstrated that physical activity, regardless of the participants' age or geographic location, can protect against distress symptoms (17). Other researchers have found that physical activity can help people relax and manage stress (44, 51). A growing number of experimental investigations suggest that increased physical activity has favourable benefits for mental health (17, 18, 52). Changes in physical activity levels were found to have a substantial inverse relationship with the degree of depression, stress, and post-traumatic stress (12). However, while behavioral therapies (such as cognitive behavioral therapy, reality therapy, family-based group therapy, and positive psychology intervention) have long been known to be successful in reducing nomophobia, adjuvant therapies (exercise or physical activity) have only recently attracted research attention (53). This calls for future prospective experimental studies investigating the effect of physical activity and exercise interventions on the nomophobia-distress relationship.

7. Conclusion

Considering the increasing amounts of time spent on smartphones, the increasing nomophobia cases, and the global digitalization over the past few years, finding ways to combat the negative consequences of the digital development seems crucial. The findings of our study indicate that physical activity moderated the effects of nomophobia on stress and anxiety, but not on depression. This study preliminarily supports the beneficial effects of physical activity on students' mental health. Our findings could be considered as a useful supplement to current preventative and intervention efforts. However, it is crucial to explore the different effects from different types of physical activities, and the contexts of practice such as recreational sports. Finally, our results confirm that the DASS-12 scale is a valid and reliable tool, which can be administered to measure depression, stress, and anxiety levels for Arabic populations. This scale will help in future Arabic research efforts.

Ethical Approval and Consent to Participate

The study received approval from the Ethics Committee of the University of Jendouba (Ref:024-2023) and adhered to institutional ethical requirements for human experimentation based on the 2013 revision of the Declaration of Helsinki. All participants voluntarily joined the study and provided informed consent before enrolling in the study protocol.

Consent for Publication

Not applicable.

Availability of Data and Materials

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

Competing Interests

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as potential conflicts of interest.

Funding

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Authors' Contributions

I.D, O.M, H.J, N.G and M.R: conception and design. F.F.R, O.M, H.J, M.S, N.G and M.B.A: analysis and interpretation of the data. I.D, W.C, T.B, F.F.R, O.M, H.J, M.S, N.G and M.B.A: drafting of the paper. I.D, W.C, T.B, F.F.R, O.M, H.J, M.S, N.G and M.B.A: revising it critically for intellectual content. All authors gave their final approval to the version that will be published.

Acknowledgements

Not Applicable.

References

1. Rodríguez-García A-M, Moreno-Guerrero A-J, Lopez Belmonte J. Nomophobia: An individual's growing fear of being without a smartphone—a systematic literature review. International Journal of Environmental Research and Public Health. 2020;17(2):580. [PMID: 31963208] [PMCID: PMC7013598] [DOI]
2. Copaja-Corzo C, Aragón-Ayala CJ, Taype-Rondan A, Nomotest-Group. Nomophobia and its associated factors in Peruvian medical students. International Journal of Environmental Research and Public Health. 2022;19(9):5006. [PMID: 35564400] [PMCID: PMC9101167] [DOI]
3. Rosales-Huamani JA, Guzman-Lopez RR, Aroni-Vilca EE, Matos-Avalos CR, Castillo-Sequera JL. Determining symptomatic factors of nomophobia in peruvian students from the national university of engineering. Applied Sciences. 2019;9(9):1814. [DOI]
4. Bano N, Khan MA, Asif U, de Beer J, Rawass H. Effects of nomophobia on anxiety, stress and depression among Saudi medical students in Jeddah, Saudi Arabia. J Pak Med Assoc. 2021;71(3):854-8.
5. Anjana KK, Suresh VC, Sachin BS, Poornima C. The relationship between nomophobia, mental health, and coping style in medical students. Indian Journal of Social Psychiatry. 2021;37(2):207-11. [DOI]
6. TOLAN ÖÇ, Karahan S. The relationship between nomophobia and depression, anxiety and stress levels of university students. International Journal of Psychology and Educational Studies. 2021;9(1):115-29. [DOI]
7. AlMarzooqi MA, Alhaj OA, Alrasheed MM, Helmy M, Trabelsi K, Ebrahim A, et al., editors. Symptoms of nomophobia, psychological aspects, insomnia and physical activity: A cross-sectional study of esports players in Saudi Arabia. Healthcare; 2022: MDPI. [PMID: 35206871] [PMCID: PMC8872081] [DOI]
8. Notara V, Vagka E, Gnardellis C, Lagiou A. The emerging phenomenon of nomophobia in young adults: A systematic review study. Addiction & health. 2021;13(2):120.
9. Guelmami N, Saidane M, Aissa MB, Rebhi M, Chalghaf N, Azaiez F, et al. Multidimensional Assessment of Student Mental Health during the COVID-19 Pandemic: A Latent Profile Analysis Integrating Positive Psychology. New Asian Journal of Medicine. 2023;1(1):20-9. [DOI]
10. Jelleli H, Hindawi O, Rebhi M, Ben Aissa M, Saidane M, Saad AR, Guelmami N. Psychometric Evidence of the Arabic Version of Nomophobia Questionnaire Among Physical Education Students. Psychology Research and Behavior Management. 2023:2383-94. [PMID: 37408785] [PMCID: PMC10319280] [DOI]
11. Denche-Zamorano Á, Franco-García JM, Carlos-Vivas J, Mendoza-Muñoz M, Pereira-Payo D, Pastor-Cisneros R, et al., editors. Increased risks of mental disorders: Youth with inactive physical activity. Healthcare; 2022: MDPI. [PMID: 35206852] [PMCID: PMC8872491] [DOI]
12. Kua Z, Hamzah F, Tan PT, Ong LJ, Tan B, Huang Z. Physical activity levels and mental health burden of healthcare workers during COVID-19 lockdown. Stress and Health. 2022;38(1):171-9. [PMID: 34231968] [PMCID: PMC8420337] [DOI]
13. Haas AN, Passos-Monteiro E, Delabary MdS, Moratelli J, Schuch FB, Corrêa CL, et al. Association between mental health and physical activity levels in people with Parkinson's disease during the COVID-19 pandemic: an observational cross-sectional survey in Brazil. Sport Sciences for Health. 2022:1-7. [PMID: 35043063] [PMCID: PMC8758246] [DOI]
14. Torlak MS, Gerçek H, Ünüvar BS. Relationship between Physical Activity and Nomophobia in University Students: A Cross-Sectional Study. 2022.
15. Bichu E, Kumar N. Association of level of physical activity in physiotherapy undergraduates with Nomophobia. Int J Phys Educ Sports and Health. 2021;8(4):96-8.
16. Tanir H. The risk of physical activity and smart phone addiction in sports high school students: an example of a state school. Pakistan Journal Of Medical & Health Sciences. 2021;15(2):706-11.
17. Carter T, Pascoe M, Bastounis A, Morres ID, Callaghan P, Parker AG. The effect of physical activity on anxiety in children and young people: A systematic review and meta-analysis. Journal of Affective Disorders. 2021;285:10-21. [PMID: 33618056] [DOI]
18. Lubans D, Richards J, Hillman C, Faulkner G, Beauchamp M, Nilsson M, et al. Physical Activity for Cognitive and Mental Health in Youth: A Systematic Review of Mechanisms. Pediatrics. 2016;138(3). [PMID: 27542849] [DOI]
19. Omar B, Dequan W. Watch, share or create: The influence of personality traits and user motivation on TikTok mobile video usage. 2020. [DOI]
20. Eysenbach G. Improving the quality of Web surveys: the Checklist for Reporting Results of Internet E-Surveys (CHERRIES). Gunther Eysenbach Centre for Global eHealth Innovation, Toronto, Canada; 2004. p. e34. [PMID: 15471760] [PMCID: PMC1550605] [DOI]
21. Guelmami N, Tannoubi A, Chalghaf N, Saidane M, Kong J, Puce L, et al. Latent Profile Analysis to Survey Positive Mental Health and Well-Being: A Pilot Investigation Insight Tunisian Facebook Users. Frontiers in Psychiatry. 2022;13:824134. [PMID: 35463494] [PMCID: PMC9021554] [DOI]
22. Yildirim C, Correia A-P. Exploring the dimensions of nomophobia: Development and validation of a self-reported questionnaire. Computers in human behavior. 2015;49:130-7. [DOI]
23. Louragli I, Ahami A, Khadmaoui A, Mammad K, Lamrani AC. Evaluation of the nomophobia's prevalence and its impact on school performance among adolescents in Morocco. Problems of Psychology in the 21st Century. 2018;12(2):84-94. [DOI]
24. Lovibond SH. Manual for the depression anxiety stress scales. Sydney psychology foundation. 1995. [DOI]
25. Chin EG. 12-Item depression, anxiety, and stress scales (Dass-12): associations with self-report measures, A semi-strcutured interview, and behavioral tasks. 2015.
26. Al-Hazzaa HM. Health-enhancing physical activity among Saudi adults using the International Physical Activity Questionnaire (IPAQ). Public health nutrition. 2007;10(1):59-64. [PMID: 17212844] [DOI]

27. Guelmami N, Chalghaf N, Tannoubi A, Puce L, Azaiez F, Bragazzi NL. Initial Psychometric Evidence of Physical Inactivity Perceived Experience Scale (Pipes): COVID-19 Pandemic as a Pilot Study. Frontiers in Public Health. 2022;10:819052. [PMID: 35392464] [PMCID: PMC8980326] [DOI]
28. Hair JF, Black WC, Babin BJ, Anderson RE, Tatham RL. Multivariate data analysis. Uppersaddle River. Multivariate Data Analysis (5th ed) Upper Saddle River. 1998;5(3):207-19.
29. Barkley JE, Lepp A. Mobile phone use among college students is a sedentary leisure behavior which may interfere with exercise. Computers in Human Behavior. 2016;56:29-33. [DOI]
30. Steiger JH. Understanding the limitations of global fit assessment in structural equation modeling. Personality and Individual differences. 2007;42(5):893-8. [DOI]
31. Hu L-t, Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. Structural equation modeling. 1999;6(1):1-55. [DOI]
32. Hair JF, Ringle CM, Sarstedt M. Partial Least Squares Structural Equation Modeling: Rigorous Applications, Better Results and Higher Acceptance. Long Range Planning. 2013;46(1):1-12. [DOI]
33. Hair JF, Hult GTM, Ringle CM, Sarstedt M, Thiele KO. Mirror, mirror on the wall: a comparative evaluation of composite-based structural equation modeling methods. Journal of the academy of marketing science. 2017;45:616-32. [DOI]
34. Fornell C, Larcker DF. Evaluating structural equation models with unobservable variables and measurement error. Journal of marketing research. 1981;18(1):39-50. [DOI]
35. Chin WW. The partial least squares approach to structural equation modeling. Modern methods for business research. 1998;295(2):295-336.
36. Cohen J. Statistical power analysis for the behavioral sciences: Academic press; 2013. [DOI]
37. Kubrusly M, Silva PGdB, Vasconcelos GVd, Leite EDLG, Santos PdA, Rocha HAL. Nomophobia among medical students and its association with depression, anxiety, stress and academic performance. Revista Brasileira de Educação Médica. 2021;45:e162. [DOI]
38. Sureka V, Suma S, Subramanian S, Brinda S, Bhagyashree N, Ramya K, Ganesh M. Prevalence of nomophobia and its association with stress, anxiety and depression among students. Biomedicine. 2020;40(4):522-5. [DOI]
39. Tams S, Legoux R, Léger P-M. Smartphone withdrawal creates stress: A moderated mediation model of nomophobia, social threat, and phone withdrawal context. Computers in Human Behavior. 2018;81:1-9. [DOI]
40. Yang J, Fu X, Liao X, Li Y. Association of problematic smartphone use with poor sleep quality, depression, and anxiety: A systematic review and meta-analysis. Psychiatry research. 2020;284:112686. [PMID: 31757638] [DOI]
41. Veerapu N, Philip RKB, Vasireddy H, Gurrala S, Kanna ST. A study on nomophobia and its correlation with sleeping difficulty and anxiety among medical students in a medical college, Telangana. Int J Community Med Public Health. 2019;6(5):2074-6. [DOI]
42. Farchakh Y, Hallit R, Akel M, Chalhoub C, Hachem M, Hallit S, Obeid S. Nomophobia in Lebanon: Scale validation and association with psychological aspects. PLoS One. 2021;16(4):e0249890. [PMID: 33878132] [PMCID: PMC8057610] [DOI]
43. Brunes A, Flanders WD, Augestad LB. The effect of physical activity on mental health among adolescents with and without self-reported visual impairment: The Young-HUNT Study, Norway. British Journal of Visual Impairment. 2015;33(3):183-99. [DOI]
44. Meyer J, McDowell C, Lansing J, Brower C, Smith L, Tully M, Herring M. Changes in physical activity and sedentary behavior in response to COVID-19 and their associations with mental health in 3052 US adults. International journal of environmental research and public health. 2020;17(18):6469. [PMID: 32899495] [PMCID: PMC7559240] [DOI]
45. López-Bueno R, Calatayud J, Ezzatvar Y, Casajús JA, Smith L, Andersen LL, López-Sánchez GF. Association between current physical activity and current perceived anxiety and mood in the initial phase of COVID-19 confinement. Frontiers in psychiatry. 2020;11:729. [PMID: 32793013] [PMCID: PMC7390883] [DOI]
46. Howard D, Dunston E, Hammermeister J, Taylor K, editors. PHYSICAL ACTIVITY, SEDENTARY BEHAVIOR, AND STRESS IN GRADUATE STUDENTS: THE PASS STUDY. International Journal of Exercise Science: Conference Proceedings; 2019.
47. Christofaro DGD, De Andrade SM, Mesas AE, Fernandes RA, Farias Junior JC. Higher screen time is associated with overweight, poor dietary habits and physical inactivity in Brazilian adolescents, mainly among girls. European journal of sport science. 2016;16(4):498-506. [PMID: 26239965] [DOI]
48. Liu S, Xiao T, Yang L, Loprinzi PD. Exercise as an alternative approach for treating smartphone addiction: a systematic review and meta-analysis of random controlled trials. International Journal of Environmental Research and Public Health. 2019;16(20):3912. [PMID: 31618879] [PMCID: PMC6843500] [DOI]
49. Bell SL, Audrey S, Gunnell D, Cooper A, Campbell R. The relationship between physical activity, mental wellbeing and symptoms of mental health disorder in adolescents: a cohort study. International Journal of Behavioral Nutrition and Physical Activity. 2019;16:1-12. [PMID: 31878935] [PMCID: PMC6933715] [DOI]
50. Peterson JA, Chesbro G, Larson R, Larson D, Black CD. Short-term analysis (8 weeks) of social distancing and isolation on mental health and physical activity behavior during COVID-19. Frontiers in Psychology. 2021;12:652086. [PMID: 33815233] [PMCID: PMC8012844] [DOI]
51. Wahl CA, Gnacinski SL, Nai MM, Meyer BB. Psychological predictors of perceived stress and recovery in sport. Sport, Exercise, and Performance Psychology. 2020;9(3):292. [DOI]
52. Stojmenović A, Katanić B, Ugrinić B, editors. Physical Activity and Mental Health. Proceedings of the IV International Scientific Conference "Sport, Recreation, Health; 2021.
53. Kim H. Exercise rehabilitation for smartphone addiction. Journal of exercise rehabilitation. 2013;9(6):500. [PMID: 24409425] [PMCID: PMC3884868] [DOI]