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Research Paper

Can physical activity attenuate the impact of internet addiction on anxiety in young adults? A moderation analysis

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ABSTRACT

Background: The potential moderators of the nexus between internet addiction (IA) and symptoms of anxiety are less understood. This cross-sectional study aimed to assess the moderating roles of physical activity (PA) and gender in the association between IA and anxiety.

Methods: A cross-sectional study of 510 Nigerian undergraduate students was carried out. IA, anxiety, and PA levels (low, moderate, and high) were assessed using Internet Addiction Test, anxiety sub-scale of Depression Anxiety Stress Scale-21, and Patient-Centered Assessment and Counseling for Exercise Plus Nutrition, respectively. Moderation analysis was applied while controlling for important covariates.

Results: The mean age of the respondents was 21.33 ± 2.63 years. The prevalence of IA and anxiety was 57.6 % and 52.6 %. IA was positively associated with anxiety (b=0.307, 95 % CI: 0.2168-0.3982, t (498) =6.660, $p < 0.001$). PA level, but not gender seem to moderate the association between IA and anxiety (F (2, 498) =3.561, p=0.029, R^2 change =0.011). Moreover, interaction between PA and gender indicated that the moderating effect of PA was less pronounced among females compared with males (F (3, 498) =2.895, p=0.035, R^2 change =0.014).

Conclusions: PA can attenuate the deleterious nexus between IA and anxiety in young adults. The attenuation of PA in IA-anxiety nexus is weaker among female young adults compared with male counterparts. PA is a viable low-cost intervention strategy in combating the effect of IA on symptoms of anxiety among young adults. Further longitudinal and experimental studies are needed to better understand the underlying mechanisms among IA, anxiety symptoms, PA, and gender.

1. Introduction

Internet use is very common among university students worldwide, as it helps them to socialize, learn, entertain and understand global affairs (Shen et al., 2023). However, the unconstrained use of internet can become problematic and lead to internet addiction (IA) (Shen et al., 2023). IA is a phenomenon that is complex and dynamic, and it has been described as uncontrolled urge or behaviour in internet usage resulting in attendant effects (Young, 1998). Among university students, particularly medical-related students, IA has been reported to be highly prevalent. The high prevalence of IA in this population and many others has been ascribed to changes in behavioural and developmental patterns, lack or inadequate parental control, and easy and unlimited access to the internet (Zhang et al., 2018; Lozano-Blasco et al., 2022; Nayak et al., 2021). Young adults are transiting from adolescence to adulthood, and are expected to make crucial life decisions independently and also make significant contributions to societal development (IOM and NRC, 2015). Young adults, who are most often university students, are in critical stage of psychological and brain development (IOM and NRC, 2015; Nanney et al., 2015; Georgiou, 1997). However, this transition poses enormous strain on many young adults, thereby making them more prone to errors in life choices, and engaging in unhealthy

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behaviours, including physical inactivity, smoking, drug use, unhealthy diet, IA, etc. (Hankinson et al., 2010; Nanney et al., 2015; Lozano-Blasco et al., 2022).

Considering that not all activities on the internet are harmful or addictive, it seems research delineating or exploring the roles of different internet habits (IHs) engaged by young population in relation to the development of IA is sparse. IH as a concept is defined as the most prominent online and offline internet activities. IHs are not only difficult to control but are also prone to be used inappropriately or excessively, leading to IA (Zheng et al., 2016; Filho et al., 2023). Some of the IHs reported in the literature in adolescents includes online gaming and gambling, social media networking, shopping, online sex, and information overload (Ying et al., 2021). These IHs are further conceptualized among university students into three main habits; gaming/gambling, social media/entertainment, and information/education use (Stanković and Nesic, 2022; Mahmoud et al., 2022). There is need for research delineating contribution of different IHs to the prevalence of IA.

Internet addiction has been reported to be associated with mental health dysfunctions, including symptoms of anxiety. Thus, IA-related anxiety may have contributed significantly to the global prevalence of anxiety of which more than 250 million individuals are affected, and ranking sixth in global disability (World Health Organisation, 2017). Specifically, consistent nexus has been shown between IA and anxiety in young adults (Shen et al., 2023; Stanković and Nesic, 2022; Kim et al., 2018; Fekih-Romdhane et al., 2023). The effect of IA on anxiety is said to be even more pronounced among medical-related university students due to high educational and professional demands involved in their training (Stanković and Nesic, 2022). Anxiety symptoms are reflected as anxious affect and thoughts, fear, sleep disturbance and adverse physical and physiological changes, such as increase in blood pressure, heart rate and sweating etc. (Park et al., 2021; American Psychiatric Association, 2015; Eysenck et al., 1992). Anxiety has also been implicated in the increased suicidal risk, depressive symptoms, and tendency to engage in abuse of harmful substances (Vorspan et al., 2015; Garber and Weersing, 2010). Thus, the need for strategies to mitigate the effect of IA on anxiety in this population.

Physical activity (PA) may serve as one of the low-cost strategies to reduce negative psychological effect of IA. Studies have shown a negative association between PA and IA, indicating that individuals who were more physically active had no or low IA (Hassan et al., 2020; Sahin and Lok, 2018; Lepp et al., 2013; Li et al., 2014; Demenech et al., 2023; Alaca, 2020). More studies have shown that individuals with higher PA levels were observed to be less anxious (Forte et al., 2022; Rebar et al., 2015; Precht et al., 2022; Zhu et al., 2019). Additionally, the effects of PA on some physiological substances like dopamine, endorphin, serotonin etc., indicates that it has capacity to influence mood and behaviour (Strasser and Fuchs, 2015). Thus, it is adducible that participation in PA improve mood and mitigate the symptoms of anxiety, and it may also reduce time spent online and invariably IA. Therefore, it is probable that PA may mitigate the deleterious IA-anxiety association.

In addition to the foregoing, there is need to understand the different moderating factors for IA-anxiety links. Evidence on gender difference in the prevalence of IA is inconclusive (Dieris-Hirche et al., 2017; Hayat et al., 2020; Su et al., 2019). However, the effect of IA on depressive symptoms is reportedly more entrenched among females (Nishida et al., 2019). Furthermore, data has indicated that female undergraduates are more prone to symptoms of anxiety than male undergraduates (Stanković and Nesic, 2022; Jovanović et al., 2019), and that PA levels vary significantly by gender (Forte et al., 2022). Furthermore, studies have also shown that IA among young adults is influenced by age (Lozano-Blasco et al., 2022), academic (Hayat et al., 2020), environmental (Ying et al., 2021), and parental factors (Ying et al., 2021). Thus, this study was aimed to investigate the roles of PA and gender in the association between IA and anxiety nexus. Specifically, this study aimed to examine (1) contribution of different IHs (social media/entertainment, gaming/gambling, and information/education) to IA, (2) association of gender and IA with anxiety, (3) associations of PA levels (low, moderate, and high) and IA with anxiety, and (4) association of PA and gender interaction with IA-anxiety nexus. Therefore, the following hypotheses were examined in this study: H1: there is significant difference in IA scores based on IHs; H2: anxiety is associated with IA; H3: anxiety is associated with gender; H4: anxiety is associated with PA levels; H5: PA moderates the association between IA and anxiety; H6: gender moderates the association between IA and anxiety; and H7: PA-gender interaction moderates the association between IA and anxiety.

2. Materials and methods

This cross-sectional study was conducted among physiotherapy undergraduates from purposively selected Nigerian Universities. These are Bayero University, Kano, Bowen University, Ogbomoso, Obafemi Awolowo University, Ile-Ife, University of Benin, Benin, University of Ibadan, Ibadan, University of Maiduguri, Maiduguri, University of Medical Sciences, Ondo, University of Lagos, Lagos, and Redeemer's University, Ede. Physiotherapy students who had physical disability or musculoskeletal dysfunctions that may prevent or hinder PA participation, and those who were on any mental health medications were excluded. The link to the online survey (Google form) was sent to the WhatsApp platforms of physiotherapy students' associations of the universities, and the focal person chosen from each school helped with the re-broadcasts of the link. The purpose of the study, inclusion and exclusion criteria was explained to the participants on the first page of the survey, with clicking on the next page indicating consent. The survey was designed to ensure anonymity of the participants, prevent more than one response from the same student, and ensure complete survey before submission. The Ethics Research Committee of the Redeemer's University, Ede, Nigeria gave approval for the study. By using the Cochran sample size formula (Cochran, 1997); a minimum sample of 384 participants was required for the study. In total, 510 physiotherapy undergraduates responded to the survey from January to June, 2023.

2.1. Measures

The Young's Internet Addiction Test (IAT) was used for assessing IA. The instrument is a self-administered questionnaire with 20 statements (e.g., how often do you check your email before something else that you need to do; how often do you snap, yell, or act annoyed if someone bothers you while you are online; how often do you try to cut down the amount of time you spend online and fail, etc.) each assessed on a 6-point likert scale ranging from 0 (not applicable) to 5 (always), with 100 being the maximum total score obtainable. Higher scores indicate higher severity of IA (Young, 2009). Participants with a total score above 30 were considered addicted to the internet, while 31-49 scores, 50-79 scores, and 80-100 scores were considered as mild, moderate, and severe IA. In this study, the Cronbach's α for IAT was 0.832. In order to delineate IHs that fuel IA, participants were further asked to indicate a major reason (information/education, gaming/gambling or social media/entertainment) they surf the internet.

The anxiety sub-scale of Depression Anxiety Stress Scale-21 (DASS-21) was used to assess the risk of anxiety symptoms of the participants. DASS-21, a shorter form of DASS-42, is a 21 item questionnaire with 7 items in anxiety domain (e.g., I was worried about situations in which I might panic and make a fool of myself; I was aware of the action of my heart in the absence of physical exertion (e.g. sense of heart rate increase, heart missing a beat); I felt scared without any good reason, etc.). The 7 items on DASS-21 anxiety-subscale, like other two subscales (depression and stress) was rated on a 4-point scale, ranging from 0 (did not apply to me at all) to 3 (applied to me very much or most of the time), with higher score suggesting higher level of anxiety symptoms (Lovibond and Lovibond, 1995). The score obtained was multiplied by

two and a score of 0–7, 8–9, 10–14, 15–19, and ≥ 20 scores on anxiety-subscale of DASS-21 were considered as normal, mild, moderate, severe, and extremely severe anxiety, respectively. The psychometric properties of DASS-21 have been established as adequate among Nigerian university students (Coker et al., 2018). The Cronbach's α for DASS-21 in this study was 0.892.

The PA of the participants was assessed using the modified version of the self-report PACE+ (Patient-Centered Assessment and Counseling for Exercise Plus Nutrition). The participants indicated the number of days they have engaged in moderate-to-vigorous PA (e.g., walking, gardening, biking, etc.) for at least 60 minutes in the past and typical week (Prochaska et al., 2001; Delisle et al., 2010). Participants with PACE+ score of 0–2 day per week, 3, 4 day per week, or ≥5 day per week were categorized into low PA, moderate PA, or high PA, respectively. PACE+ has been validated among youth (Murphy et al., 2015). The Cronbach's α for PACE+ in this study was 0.818.

2.2. Covariates

Some important covariates, including age, gender, family type (nuclear or extended), family income and academic performance were assessed. About academic performance, students were required to rate their recent academic performance on a 4- point likert scale from poor (1 point) to excellent (4 points), with higher score indicating higher academic performance. Family income was classified based on Nigerian monthly minimum wage as low (< #30,000), medium (#30,000-#70,000), and high (>#70,000).

2.3. Data analysis

Frequency, percentage, means, and standard deviation was used to summarize data. The normality of continuous data was examined by the Kolmogorov-Smirnov test. Normally distributed variables were expressed in mean and standard deviation, while categorical variables were expressed in frequencies and percentages. Chi-square was used to investigate the gender differences in IHs and PA levels, while independent t-test and Mann Whitney U test were used to assess gender differences in IA and anxiety scores. The differences in IA and anxiety scores in terms of IHs and PA levels were investigated by one-way ANOVA and Kruskal Wallis test. To investigate the moderating role of gender, PA, and interaction of gender and PA in the association between IA and anxiety, a double moderation analysis with PROCESS macro (version 4.0) with 10,000 bias-corrected bootstrap samples (model 2) was performed. The model was adjusted for age, family type, family income, and academic performance. Alpha level was set at $p < 0.05$. Data was analysed with SPSS 21.0 version (SPSS Inc., Chicago, Illinois, USA).

3. Results

The majority (62.4 %) of the participants were female, while the sample mean age and standard deviation was 21.33±2.63 years. The prevalence of anxiety symptoms and IA were 52.6 % and 57.6 %. Social media/entertainment (66.8 %) was the major IH of the participants, while 34.1 %, 20.4 %, and 45.5 % of the sample reported low, moderate, and high PA levels, respectively. Table 1 presents the general characteristics of the participants. The differences in IA, anxiety symptoms, PA, and IHs are presented in Table 2. Symptoms of anxiety differs significantly by gender, with female displaying higher levels of anxiety in comparison to male ($Median_{diff}$=2.0; U=2.784, p=0.005). Further, there was significant difference in IA scores based on IHs ((F(2, 507)= 8.924, $p < 0.001$). The Tukey post hoc comparisons showed that IA mean scores for those engaged in gaming/gambling (37.61 ± 15.91) and social media/entertainment (36.12 ± 13.84) were significantly higher than IA sample mean score (34.69 ± 14.01), and also higher than those whose IH was education/information use (30.49 ± 13.20). However, there were no gender differences in IA, PA levels and IHs (p>0.05).

Table 1
General characteristics of the participants (N=510)

Variable	n (%)	Mean ± SD
Gender		
Male	192(37.6)	
Female	318(62.4)	
Age (years)		21.33±2.63
Academic performance		2.83±0.70
Poor	8(1.57)	
Average	151(29. 61)	
Good	269(52.75)	
Excellent	82(16.07)	
Family type		
Nuclear	453(88.80)	
Extended	57(11.20)	
Family income class		
Low	44(8. 60)	
Middle	424(83.20)	
High	42(8.20)	
Internet habits		
Social media/entertainment	341(66.80)	
Gaming/gambling	31(6.10)	
Information/education	138(27.10)	
Physical activity		
Low	174(34.10)	
Moderate	104(20.40)	
High	232(45.50)	
Internet Addiction Test		34.69±14.01
Normal	216(42.40)	
Mild internet addiction	217(42.50)	
Moderate internet addiction	77(15.10)	
Anxiety score of DASS-21		8.0 (12.0)[a]
Normal	241(47.40)	
Mild	41(8.0)	
Moderate	118(23.10)	
Severe	44(8.60)	
Extremely severe	66(12.90)	

n frequency, % percentage, SD standard deviation, DASS depression, anxiety and stress scale,
[a] median (interquartile range).

There were also no significant differences in IA and anxiety symptoms in respect to PA levels (p>0.05).

The results of the double moderation of PA and gender in the relationship between IA and anxiety are presented in Table 3. The overall model are useful in predicting anxiety and are responsible for about 22.1 % of variance observed in the anxiety symptom, F(11,498)= 12.837, $p < 0.001$, R^2=0.221. The results further show that IA (b=0.307, 95 % CI: 0.2168-0.3982, t(498)=6.660, $p < 0.001$) is positively associated with anxiety, while gender (b= -1.838, 95 % CI: -3.231--0.445, t(498)= -2.592, p=0.010) and age (b= -0.757, 95 % CI: -1.023--0.491, t(498)= -5.594, $p < 0.001$) are negatively associated with anxiety. PA is not significantly associated with anxiety (p>0.05). The addition of PA significantly moderates the association between IA and anxiety (F(2, 498)=3.561, p=0.029, R^2 change =0.011), but not the addition of gender (F (1, 498)=1.792, p=0.181, R^2 change =0.003). Moreover, the combination of PA and gender significantly moderate the IA-anxiety association (F(3, 498)=2.895, p=0.035, R^2 change =0.014). Specifically, the results show that increasing in PA reduces the impact of IA on anxiety symptom. However, the moderating effect of PA in the association between IA and anxiety appears to be more pronounced in males than females (Fig. 1).

4. Discussion

This study assessed the extent to which different IHs fuel IA, and whether and how PA and gender directly moderate the association between IA and anxiety among undergraduate physiotherapy students. First, the findings of this study showed a high prevalence of IA (57. 6 %) among Nigerian physiotherapy undergraduates. Previous studies among university students have reported similar high prevalence of IA (Nayak

Table 2
Differences in internet addiction, anxiety symptoms, physical activity and internet habits

Variable	Gender		χ2	p-value	
	Female	Male			
Internet habits n (%)			2.051	0.359	
Social media/entertainment	220 (64.50)	121 (35.50)			
Gaming/gambling	18 (58.10)	13 (41.90)			
Information/education	80 (58.0)	58 (42.0)			
Physical activity (PA)			1.170	0.557	
Low PA	114 (65.50)	60 (34.50)			
Moderate PA	64 (61.50)	40 (38.50)			
High PA	140 (60.30)	92 (39.70)			
Variable	Female	Male	U/T	p-value	
Anxiety (Median [IQR])	8.0 (12.0)	6.0 (10.0)	2.784†	0.005*	
Internet Addiction (Mean ±SD)	33.94±13.42	35.93±14.90	1.555	0.121	
Variable	Social media/entertainment	Gaming/gambling	Information/education	F/H	p-value
Internet addiction (Mean ± SD)	36.12±13.84[a]	37.61±15.91[a]	30.49±13.20[b]	8.924	<0.001*
Anxiety (Median [IQR])	8.0 (10.0)	10.0 (16.0)	8.0 (10)	2.232‡	0.328
Variable	Low PA	Moderate PA	High PA	F/H	p-value
Internet addiction (Mean ± SD)	35.87±13.72	35.26±15.08	33.72±13.74	1.062	0.346
Anxiety (Median [IQR])	8.0 (12.0)	8.0 (10.0)	8.0 (12.0)	0.151‡	0.927

n frequency, % percentage, SD standard deviation,
* indicates statistical significance, superscripts (a, b, c) indicates means with different superscript are significantly different while means with same superscript are not significantly different,
† indicates Mann Whitney U test statistics,
‡ indicates Kruskal Wallis test statistics, IQR interquartile range.

Table 3
Double moderation of physical activity and gender in the association between internet addiction and anxiety

Variable	Coefficient	Se	T	p-value	LLCI	ULCI
Constant	26.5566	3.1815	8.3471	<0.001	20.3057	32.8075
IA	0.3075	0.0462	6.6608	<0.001	0.2168	0.3982
Low vs. Moderate PA	0. 664	0.928	0.715	0.475	-1.159	2.486
Low vs. High PA	0.128	0.743	0.173	0.863	-1.332	1.589
Int-1(IA*Low vs. Moderate PA)	-0.032	0.063	-0.510	0. 610	-0.157	0.092
Int-2 (IA*Low vs. High PA)	-0.137	0.054	-2.529	0.012	-0.244	-0.031
Gender	-1.838	0.709	-2.592	0.010	-3.231	-0.445
Int-3 (IA*Gender)	-0.063	0.047	-1.338	0.181	-0.156	0.030
Age	-0.757	0.135	-5.594	<0.001	-1.023	-0.491
Family type	1.429	1.066	1.340	0.181	-0. 666	3.523
Family income	-0. 673	0.844	-0.798	0.425	-2.331	0.985
Academic performance	-0.023	0.487	-0.048	0.962	-0.981	0.934
Tests of highest order unconditional interactions						
	R-square change	F	P-value			
IA*PA	0.011	3.561	0.029			
IA*Gender	0.003	1.792	0.181			
PA*Gender	0.014	2.895	0.035			
Conditional effects of internet addiction on anxiety symptoms at levels of physical activity and gender						
PA Levels	Gender	Effect	Se	t (p-value)	LLCI	ULCI
Low PA						
	Female	0.307	0.046	6. 661(<0.001)	0.217	0.398
	Male	0.244	0.049	4.999(<0.001)	0.148	0.340
Moderate PA						
	Female	0.275	0.053	5.199(<0.001)	0.171	0.379
	Male	0.212	0.055	3.829 (<0.001)	0.103	0.320
High PA						
	Female	0.170	0.040	4.219(<0.001)	0.091	0.249
	Male	0.107	0.045	2.368(0.018)	0.018	0.195

et al., 2021; Stanković and Nešić, 2022; Sharma et al., 2014; Bagdey et al., 2018; Omoyemiju et al., 2021). The findings showed that 72.9 % of the students surf the internet for non-educational purposes. Furthermore, gaming/gambling and social media/entertainment, and not information overload or educational use; seem to fuel IA among university students. Specifically, in this study, gaming/gambling followed by social media/entertainment use contributed more to the IAT scores observed among the students than for information/education purpose. In fact, the mean IAT scores among the students that use internet for information/education purpose was even lower than the sample mean IAT scores. Similar to these findings, previous reports have shown that university students' IHs are more of pleasure and entertainment seeking than for other purpose (Nayak et al., 2021; Stanković and Nešić, 2022). Other researchers have also reported that these habits (social media, gaming

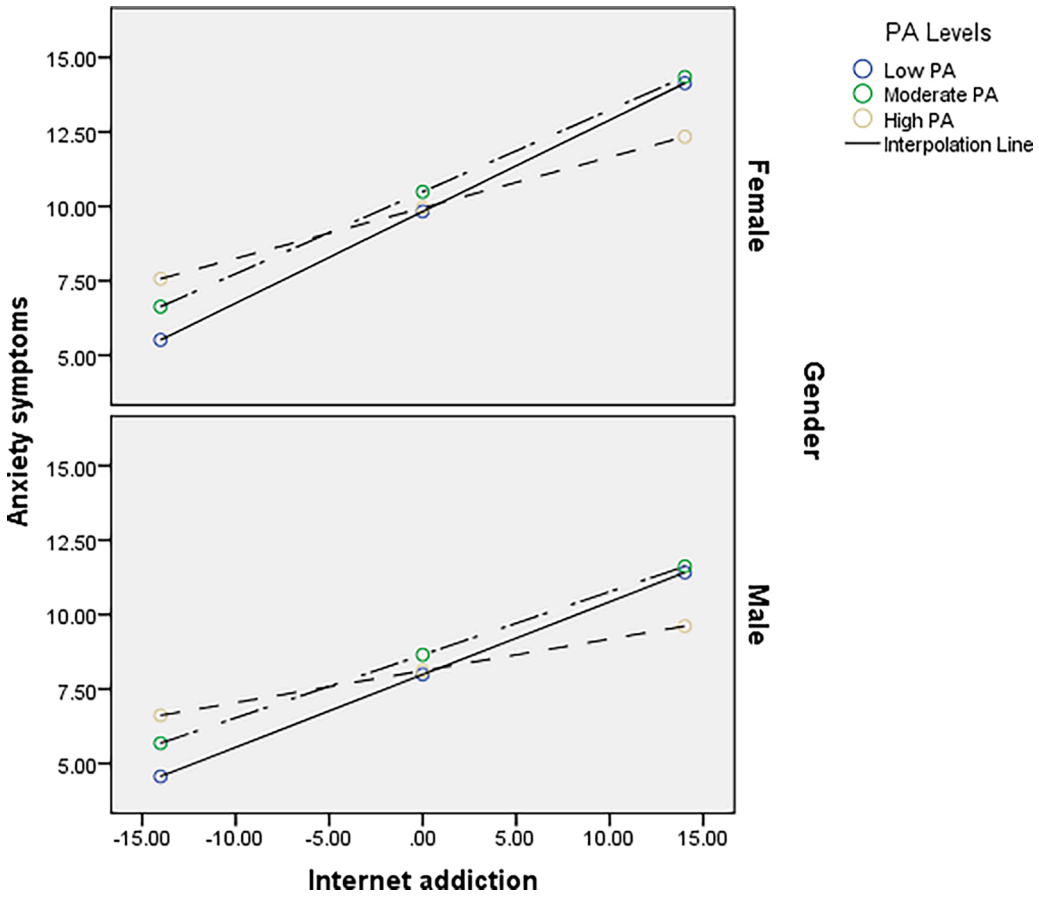

Fig. 1. Graph showing double moderation of physical activity and gender in the association between internet addiction and anxiety.

and gambling) are addictive and prevalent among individuals with IA (Stanković and Nešić, 2022; Mahmoud et al., 2022; Korkeila et al., 2010; Gentile et al., 2011; Weinstein and Lejoyeux, 2010).

In line with the findings of similar studies (Shen et al., 2023; Stanković and Nešić, 2022; Kim et al., 2018; Fekih-Romdhane et al., 2023), IA was positively associated with anxiety among university students in this study. The link between IA and anxiety has been explained in the literature. Enez Darcin et al. (2016) posited that withdrawal syndrome is a major link between IA and anxiety. Considering that majority of these students seek pleasure through social media, entertainment, gambling and gaming from the internet, withdrawing from these activities, which are mostly addictive, may elicit or precipitate the symptoms of anxiety. Furthermore, the increasing internet use among medical-related university students due to educational demands are said to acutely increase anxiety in this population (Stanković and Nešić, 2022). The high level of anxiety among medical-related students has been associated with the tremendous academic stress, which they want to dissipate through engaging in harmful behaviours, including IA (Shen et al., 2023).

The results of this study indicate that PA independently moderates the association between IA and anxiety. The findings suggest that increasing in PA levels weakens the impact of IA on anxiety, i.e. physiotherapy students with higher PA levels reported lower symptoms of anxiety occasioned by IA. This finding is not in variance with the reports of mechanisms underlying associations among IA, mental health, and PA. One of the possible mechanisms that can explain reason PA weakens the effect of IA on anxiety is the substitution mechanism. Studies have reported that individuals with higher PA levels engage less in internet activity and are less addicted to the internet (Hassan et al., 2020; Sahin and Lok, 2018; Lepp et al., 2013; Li et al., 2014; Demenech et al., 2023; Alaca, 2020). This suggest that time that may be used to surf the internet has been substituted with PA participation leading to no or low IA, and invariably less symptoms of anxiety. Another mechanism, by which PA may lessen IA-anxiety interaction, as seen in this study, is the enhancement of self-regulation skill by PA. Individuals with adequate PA tend to have high self-regulation, which plays a key role in the choice of healthy habits (Boraita et al., 2020; López-Gil et al., 2020). Low or lack of self-control is a major factor facilitating IA (Shen et al., 2023; Błachnio et al., 2023). In other words, individuals with higher PA levels may be able to control thought, emotion, impulses and other impulsive or learned habits, including IA (Shen et al., 2023), and thereby reported low symptoms of anxiety. Furthermore, individuals with higher PA levels are known to adopt positive coping practices to deal with stressful life events other than resulting to harmful practices (Cairney et al., 2014). There is a pathway among stress, anxiety and IA. It has been shown that medical students tend to route their high academic stress-induced anxiety through engaging in harmful habit of IA (Shen et al., 2023). Thus, engaging in PA may help them to adopt better strategies in coping with stress other than IA, which may reduce the impact on anxiety symptoms. Lastly, evidence has shown that PA improves mood and mitigates the symptoms of anxiety in this population and others (Forte et al., 2022; Precht et al., 2022; Stoduto et al., 2023), indicating that physiotherapy students with higher PA levels reported low level of IA-induced symptoms of anxiety probably due to direct positive impact of PA.

In this study, gender did not independently moderate the association between IA and anxiety; however, the interaction between PA and gender suggests that the moderating role of PA is gender bias. Specifically, PA attenuates the effect of IA on anxiety symptoms better among male physiotherapy undergraduates than their female counterparts. Similar results were observed by Forte et al. (2022), wherein the moderating role of PA in the association between screen time and

anxiety symptoms in adolescents was different based on gender. Evidence regarding gender difference in IA prevalence is inconclusive (Stanković and Nešić, 2022). In this cohort of students, no gender difference in IA was observed. The more probable reasons for the gender-specific moderation of PA in IA-anxiety nexus may be related to gender sensitivity in anxiety prevalence, and IA-anxiety pathway. There is consistent evidence that symptoms of anxiety is more prevalent among women than men (Stanković and Nešić, 2022; Forte et al., 2022; Jovanović et al., 2019), and that IA is more harmful to the mental health of women than men (Stanković and Nešić, 2022). In this study, symptom of anxiety was significantly higher in women than men. These indicate that similar level of PA may not achieve the same positive effects on symptoms of anxiety, and on IA-anxiety path in women compared to men. Another plausible reason for the gender difference in the moderating role of PA in IA-anxiety nexus may be due to gender difference in PA participation. Generally, male appear to be more physically active than female (Sahin and Lok, 2018; Forte et al., 2022; Fuentealba-Urra et al., 2021), and this may account for lower positive effect of PA in the association between IA and anxiety symptoms among female physiotherapy students. Though not statically significant, in our study, male students were more physically active than female. There are few potential limitations to the findings of this study. The symptoms of anxiety and PA levels of the participants were assessed with self-report questionnaire, though validated, but can introduce report bias, over-and under-estimation of anxiety symptoms and PA levels. The study design was cross-sectional, thus, causality and absolute directionality of associations among PA, IA, and anxiety cannot be inferred. Lastly, we did not delineate the potential difference in the effects of different modalities of PA such as anaerobic and aerobic to the association between IA and anxiety. Therefore, future longitudinal and experimental studies with the use of objective assessment of PA (e.g. accelerometer) and anxiety symptoms are needed to consolidate our findings. Furthermore, studies assessing whether different PA modalities play a role in the relationship between IA and anxiety are recommended.

5. Conclusion

There was high prevalence of IA among Nigerian physiotherapy undergraduate students, which is fueled mostly by social media, entertainment, gaming, and gambling. IA was positively associated with anxiety, and this association seems to be attenuated by PA. The attenuation by PA in IA-anxiety nexus was less pronounced among female students compared with the male counterparts. Thus, PA is a viable low-cost intervention strategy in combating the effect of IA on symptoms of anxiety among young adults.

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CRediT authorship contribution statement

Adekola B. Ademoyegun: Conceptualization, Methodology, Writing – original draft, Writing – review & editing. **Adebukola G. Ibitoye:** Data curation, Methodology, Writing – original draft, Writing – review & editing. **Joshua Afolabi:** Data curation, Methodology, Writing – original draft, Writing – review & editing. **Opeyemi A. Idowu:** Funding acquisition, Formal analysis, Data curation, Writing – original draft, Writing – review & editing. **Henrietta Fawole:** Data curation, Formal analysis, Writing – original draft, Writing – review & editing. **Taofeek O. Awotidebe:** Funding acquisition, Formal analysis, Data curation, Writing – original draft, Writing – review & editing. **Chidozie E. Mbada:** Funding acquisition, Formal analysis, Data curation, Writing – original draft, Writing – review & editing.

Declaration of competing interest

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

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