Physical activity and depression during the COVID-19 pandemic in Nigeria: Does age and gender make a difference?

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Abstract

Background

There is overwhelming evidence indicating that depression may be reduced by physical activity (PA) but studies in lower- and middle-income countries and those that involved data at higher physical activity doses were underrepresented. The current study investigated the associations between PA levels (vigorous, moderate, walking and sitting) and depression, and tested whether age and gender moderates the link between PA and depression during the COVID-19 pandemic.

Method

Participants were 857 adults (51.0% women; aged 18–69, mean age = 29.71, *SD* = 10.84 years) who completed an online survey as part of the General Health, Speech and Physical Activity Relationship Assessment Study in Nigeria. Physical activity was assessed using the International Physical Activity Questionnaire (IPAQ) while depression was measured using the Patient Health Questionnaire (PHQ-9).

Results

Results of Hayes PROCESS macro indicated that those who engaged in vigorous PA reported lower levels of depression. Sitting, walking and moderate PA were not significantly associated with depressive symptoms. Older participants reported less symptoms of depression. Women had higher depressive symptoms compared to men. The interactions of age and gender with the PA levels were not significant, which showed that age and gender did not moderate the relationships of PA and depression.

Conclusion

Health practitioners should encourage people to engage in vigorous PA in order to reduce levels of depression and improve mental health in the general population.

Introduction

In most parts of the world, the outbreak of the highly infectious Coronavirus (COVID-19) generated serious public health and economic crisis (Adam, 2023; World Health Organisation, 2020). COVID-19 was declared a pandemic on 11th March, 2020 after more than 118,319 confirmed cases and 4,292 deaths had been recorded from various continents of the world (World Health Organisation, 2020). Shortly before this declaration, Nigeria, the most populous country in Africa, recorded her first case on 27th February 2020 (Adegboye et al., 2020). By October 24, 2020, Nigeria had 61,930 confirmed cases with 1,129 deaths (NCDC COVID-19 NIGERIA 2020); and became the first West African country with a confirmed case of the novel COVID-19 (Olurounbi & Bala-Gbogbo, 2020).

Following the burden caused globally by COVID-19 such as high spread and mortality rate of the virus, in addition to inadequate mental health care system in Nigeria, inhabitants experience fear, depression, and anxiety that already caused some long-term consequences (Oyem, Ichipi-Ifukor & Obi-Ojinika, 2021). Although depression remained a challenging issue among Nigerians before the onset of COVID-19, evidences abound that the pandemic caused a surge in depression cases (Alli-Hakeem, 2021; Oginni et al., 2021; Olaseni, 2020). The potential adverse mental health outcomes of COVID-19 pandemic in Nigeria may be attributed to the disease's widespread fear and stigma, disruption of healthcare access during lockdowns, economic impact, overburdened and disparate healthcare systems, and the nation's already high prevalence of mental health disorders (Chukwuorji & Iorfa, 2020; Mbamalu, 2019; Otto & van Roekel, 2022). It is essential to comprehend the scope and nature of COVID-19's psychological effects in Nigeria in order to design the necessary preventive treatments to fend off or lessen the negative effects.

An increase in sitting time and sedentariness may worsen the chance of developing depression, and may reduce the quality of life of even a healthy adult when the lockdown is relaxed (Chen et al. 2020). Interestingly, regular participation in physical activity and exercise (walking, jogging, cycling, and dancing) is known to have many health benefits (Cha et al. 2016), more especially during the Covid-19 lockdown. It is recommended that adults should undertake at least 30 min of moderate physical activity every day or at least 15 min of vigorous physical activity every day for at least 5 days a week (U.S. Department of Health & Human Service 2018).

A recent systematic review and meta-analysis has demonstrated that regular PA, is associated with improved cognitive functioning, better overall mental health and enhanced well-being (e.g., Pearce et al., 2022). The associations between engaging in PA and significantly low depression rates (suggests substantial mental health benefits from being physically active, even at levels below the public health recommendations Pearce et al., 2022). Physical activity may also have other potential positive effects, which help prevent depression such as improved pulmonary function, and cardiovascular, and aerobic fitness, stronger immunity, enhanced muscle strength, higher bone density, stress reduction, and better emotional stability (Cha et al. 2016). Pearce et al. (2022) observed that limited studies have been conducted in lower- and middle-income countries on the association between PA and mental health outcomes. Given that studies on PA and depression in sub-Saharan African countries (e.g., Nigeria) are largely unexplored and data underrepresented, the first aim of the present study is to examine the contributions of PA in depression among Nigerian adults during the COVID-19 pandemic.

Furthermore, a recent study (Lin et al., 2020) reported that there are differences in impact of PA on depression on account of activity level among Chinese adults. Specifically, lower depression cores were associated with moderate PA but not vigorous PA and walking. Except a few (e.g., Lin et al., 2020), majority of the studies on PA and depression have mostly considered the amount of PA (duration) and neglected other important characteristics of PA such as frequency and intensity. This gap has been noted in existing literature (e.g., Helgadottir et al., 2017; Lin et al., 2020; Marques et al., 2020). Therefore, the present study found it worthwhile to consider intensity differentiation in PA (vigorous PA, moderate PA,

and walking as well as time that was spent sitting on a weekday) and their impacts on depression in a sub-Saharan African sample.

Two sociodemographic characteristics that have received reasonable attention with respect to mental health during the pandemic are age and gender (Zhu & Upenieks, 2022). Evidences of age and gender differences in depression and anxiety as well as PA also exist in the literature. Older age was associated with less depression in Canada (Nwachukwu et al., 2020), China (Hou et al., 2020; Wang et al., 2020), Japan (Fukase et al., 2022), United States (Bruine de Bruin, 2021; Zhu & Upenieks, 2022), United Kingdom (O'Connor et al., 2021). Women were more likely than men to report symptoms of depression as shown by studies in Australia (Hammarberg et al., 2020), Europe (Vallières et al., 2022), China (Hou et al., 2020). In a sample of Nigerian students, Idowu et al. (2022) compared both genders especially with regard to challenging situations as covid-19, and observed that females had more depression compared to males. Most of the studies on age and gender differences in depression draw on data collected from developed countries; and thus may underestimate the potential effects of the pandemic on mental health. The existing study in Nigeria (Idowu et al., 2022) obtained data from only medical students from three universities in southwestern Nigeria within the first six months of the first reported case of the COVID-19 pandemic. Studies on wider range of adults and conducted at later stages of the pandemic in Nigeria is important. As a second objective, therefore, we examine age and gender differences in depression using data from the sub-Saharan African setting collected about one year into the COVID-19 pandemic. This is necessary in order to build a collective body of knowledge.

Studies have also shown that gender and age can be moderators of associations between several outcomes (Chukwuorji et al. 2017; Onyedire et al., 2021). In some related studies, PA level was found to differentially influence the fear of COVID-19 depending on one's gender (e.g., Alsalhe et al., 2020), and PA promoted wellbeing especially in middle-aged compared to older adults (Lin et al., 2020). Two meta-analyses (Conn, 2020; Gordon et al., 2018) tested the moderating effect of gender and age on the effectiveness of exercise interventions on depressive symptoms, and found no such effect. However, moderator analysis in meta-analyses has methodological problems and limited power. Therefore, no firm conclusions can be drawn from the results (Hu et al., 2020). Pearce et al. (2022) suggested the investigation of possible gender and age (or geographical subgroups) differences in the role of PA on mental health. Investigating the impact of PA on mental health of African populations and if gender and age moderates these effects is urgent and key to developing targeted and effective strategies to address the challenge. As a second study objective, we focus on whether one's age and gender might moderate the relationship between PA and depression during the pandemic in Nigeria. We hypothesised as follows: (1) PA will be associated with reduced levels of depression. (2) Older adults will report less symptoms of depression. (3) Women will report higher symptoms of depression. (4) Age will moderate the link between PA and depression, such that PA will be more strongly associated with less depression for older adults compared to younger adults. (5) Gender will moderate the link between PA and depression, such that PA will be more strongly associated with less depression for men compared to women.

Method

Participants

The sample included 857 participants (49% male & 51% female) aged 18–69 years with a mean age of 29.71 years (*SD* = 10.84). While 75.5% of them were vaccinated, 24.5% were not and majority of them consider their health status as mostly good to excellent. A significant number of students participated in the study and majority of the sample had normal weight. Detailed socio-demographic characteristics of the participants are provided in Table 1.

Measures

Participants completed a form that assessed their demographic characteristics as well as other two measures, namely: Patient Health Questionnaire 9 (PHQ-9) and International Physical Activity Questionnaire short version (IPAQ-SF).

Patient Health Questionnaire-9 (PHQ-9)

The PHQ-9 (Spitzer et al., 1999) assesses the occurrence of depressive symptoms over the past two weeks and to monitor its severity. In other words, it rates the frequency of the symptoms which factors into the scoring severity index. Each item is scored on a 4-point response format ranging from 0 = “not at all” to 3 = “nearly every day”. The total score ranges from 0 to 27 with scores of 5–9 indicating ‘mild depression’ 10–14 ‘moderate depression’ 15–19 ‘moderately severe depression and ≥ 20 ‘severe depression’ (Spitzer et al., 2014). Studies in other populations reported Cronbach alpha of .85, .85 and .80 respectively (Adewuya et al., 2006; Peng et al., 2020; Molebatsi et al., 2020) while this present data set yielded a Cronbach’s alpha of .82.

International Physical Activity Questionnaire (IPAQ-SF)

The IPAQ-SF (Craig et al., 2003) is a self-report measure of physical activity (PA) developed as an instrument for cross-national assessment and monitoring of physical activity and inactivity. It is a seven (7) item questionnaire that collects information on the number of days and time spent on physical activity in ‘vigorous physical activities’ ‘moderate physical activities’ and walking for at least ten (10) minutes at a time in the last seven (7) days as well as time that was spent sitting on a weekday. Respondents were asked to indicate the number of days per week, hours and minutes per day they spent doing PA within the categories. They may also indicate that they are not sure of the activity undertaken. These activity categories may be treated separately to obtain the specific activity: low activity, moderate or high activity level patterns that could be interpreted as below, meeting and exceeding recommendations respectively (Healey et al., 2020). The IPAQ-SF has been used in Nigerian sample (Oyeyemi et al., 2011). In the present study, we obtained a Cronbach’s alpha of .84.

Procedure

Ethical approval for this study was obtained from the Health Research Ethics Committee of the University of Nigeria Teaching Hospital Ituku-Ozalla (NHREC/05/01/2008B-FWA00002458-IRB00002323). The study was part of an international project that seek to understand how physical activity and non-linguistic

elements of speech are associated with anxiety, depression and coping during the C0VID 19 pandemic. The questionnaire package for the data collection was in English language. The web-based platform, Surveylex that can be taken at any time through a URL link across devices like laptop or smart phone was used for the data collection. The Nigerian research team employed the help of research assistants who were trained in the use of Surveylex web-based survey developed by Sonde Health for the data collection. To be sure these assistants understood the use of the Surveylex, they were asked to participate in the test run of the software which was not part of the data collected for the analyses. Thereafter, participants were recruited from the community through social media platforms especially WhatsApp and through direct email invitations to prospective respondents who in turn shared to their contacts. A click on Nigeria with her flag takes them to all the information about the research as well as informed consent form and right to participate. Participants needed to be 18 years of age or older, have access to the internet and voluntarily accept to participates in the study. They were informed of the confidentiality of the study and that their participation was anonymous. However, they were asked to include their phone numbers where it was required for an instant airtime reward upon completion and submission of the survey. Data collection took place between September, 2021 and November, 2022.

Statistical Analysis

Hayes (2018) regression-based PROCESS macro for SPSS was used to predict each mental health outcome based on age, gender, and PA. The Hayes PROCESS macro is a logistic regression path analysis modeling tool used for estimating two-way interactions in moderation models along with simple slopes and regions of significance for probing interactions. The robust PROCESS macro is suitable for measuring the moderation or interactive effects (Hayes, 2018), and it is preferable to ordinary regression analysis in moderation research. PROCESS conducts regression-based path analysis and creates product terms to analyze interaction effects, automatically centering the predictor variables prior to analysis. It is currently the most acceptable method in tests of moderation in behavioural sciences (see Chukwuorji et al. 2020; Onyedire et al. 2019). If a product term (that is, interaction of predictor and moderator) was significant, it would mean that the association between the relationship variable (e.g., PA) and the criterion variable (e.g., depression) was either stronger or weaker in the presence of the moderator(s) (e.g., gender).

Results

Table 1
Demographic characteristics of participants and mean scores on study variables (*N* = 857)

Demographic Variable	Description	Statistic
Age years, *M*(*SD*)	Range = 18–69 years	29.71 (10.84)
Gender, *n*(%)	Male	420 (49.0)
	Female	437 (51.0)
COVID-19 Vaccination, *n*(%)	Vaccinated	647 (75.5)
	Not vaccinated	210 (24.5)
Health status, *n*(%)	Poor	4 (0.5)
	Fair	44 (5.1)
	Don't know	6 (0.7)
	Good	193 (22.5)
	Very Good	335 (39.1)
	Excellent	275 (32.1)
Residence, *n*(%)	Small Village	36 (4.2)
	Major Town	615 (71.8)
	Country Capital	1 (0.1)
	Major Village	27 (3.2)
	Small Town	178 (20.8)
Employment Status, *n*(%)	Unemployed	88 (10.3)
	Student	413 (48.2)
	Formal Employment	181 (21.1)
	Sell Employed/Business	134 (15.6)
	Consultancy	26 (3.0)
	Homemaker	8 (0.9)
	Retired	7 (0.8)
Education, *n*(%)	Secondary School	244 (28.5)
	Technical/Vocational/ College	115 (13.4)
	Bachelor's Degree	387 (45.2)

Note: n = number; *M* = mean; *SD* = standard deviation

Demographic Variable	Description	Statistic
	Master's Degree	70 (8.2)
	PhD	41 (4.8)
Weight	Underweight	23 (2.7)
	Normal Weight	760
	Overweight	70 (8.2)
	Obese	4 (0.5)
COVID Test	0–3	.17 (.51)
Vigorous physical activity, *M*(*SD*)	Range = 0-11200	850.97 (1640.70)
Moderate physical activity, *M*(*SD*)	Range = -420-5600	435.53 (848.59)
Walking for 10 minutes, *M*(*SD*)	Range = 0-4620	742.37 (1005.32)
Sitting, *M*(*SD*)	Range = 0-1000	489.04 (361.63)
Depression, *M*(*SD*)	Range = 0–27	5.54 (6.38)
Note: n = number; *M* = mean; *SD* = standard deviation		

Table 1 shows that there were males and females were almost equally represented. Most of the participants have not been vaccinated for COVID-19. Their health status was mostly good to excellent, and majority of them had normal weight. There were also more bachelor's degree holders in the sample. They mostly reside in major towns and small towns. There were significantly more students in the sample.

Table 2
Pearson's correlations of demographic factors, physical activity and depression

Variables		1	2	3	4	5	6	7	8	9
1	Age	-								
2	Gender	.04	-							
3	COVID Test	− .01	− .07*	-						
4	COVID Vaccine	.11**	− .06	.30***	-					
5	Education	.49***	− .03	− .03	.11**	-				
6	Vigorous Physical Activity	− .03	− .20***	.10**	.05	− .07*	-			
7	Moderate Physical Activity	− .03	− .13***	.02	.02	− .10**	.61***	-		
8	Walking for 10 minutes	.02	− .09*	− .00	− .04	− .02	.30***	.45***	-	
9	Sitting time	.07	− .06	− .02	.01	.09**	.04	.09**	.13***	-
10	Depression	− .17***	.10**	.02	− .03	− .13***	− .13***	− .08*	− .08*	− .08*

Note. *$p < .05$; **$p < .01$; ***$p < .001$; Gender (Coded 0 = males, 1 = Females), COVID Vaccine (1 = No, 2 = Yes)

In Table 2, it was found that age was positively associated with not being vaccinated and but negatively correlated with depression. The male gender was associated with being tested for COVID-19, high engagement in vigorous moderate physical activities, and walking, while the female gender was more associated with depression. Being tested for COVID-19 positively associated with being vaccinated and vigorous physical activity. Being vaccinated associated positively with higher level of education. Higher level of education associated negatively with vigorous and moderate physical activity, and depression, but associated positively with sitting time. Vigorous physical activity correlated positively with moderate physical activity and walking, but was associated negatively with depression. Moderate physical activity was associated positively with walking and sitting time, but negatively with depression. Walking associated positively with sitting time, but negatively with depression. Sitting time correlated negatively with depression.

Table 3
The Hayes PROCESS Macro results for predicting depression by vigorous physical activity, with age and gender as moderators

Variables	*B*	*t*	*p*	95%*CI*	R^2	*F*
Vigorous Physical Activity (VP)	− .02	-3.37	.001	[-.04, − .01]	.05	9.71 (5, 851)***
Age	− .11	-5.29	.000	[-.15, − .07]		
VP * Age	.00	− .65	.517	[.00, .00]		
Gender	.94	2.29	.022	[.14, 1.75]		
VP * Gender	.00	− .50	.617	[-.00, .00]		
Note: *CI* = Confidence Interval						

Results in Table 3 showed that vigorous physical activity was negatively associated with depression (*B* = − .02, *p* < .01). The *B* showed that each unit rise in vigorous physical activity was associated with a − .02 decrease in depression. Age was negatively associated with depression (*B* = − .11, *p* < .001). The *B* showed that each unit rise in age was associated with a − .11 decrease in depression. The interaction of vigorous physical activity and age was not significant (*B* = .00), indicating that age did not moderate the relationship between vigorous physical activity and depression. Gender was positively associated with depression (*B* = .94, *p* < .05), indicating being female was associated with increase in depression. The interaction of vigorous physical activity and gender was not significant (*B* = .00), indicating that gender did not moderate the relationship between vigorous physical activity and depression. The R^2 of .05 for the model indicated that 5% of the variance in depression was explained on account of the entire variables, *F* (5, 851) = 9.71.

Table 4
The Hayes PROCESS Macro results for predicting depression by moderate physical activity, with age and gender as moderators

Variables	*B*	*t*	*p*	95%*CI*	R^2	*F*
Moderate Physical Activity (MP)	.00	-1.86	.064	[-.00, .00]	.05	8.64 (5, 851]***
Age	− .11	-5.27	.000	[-.14, − .07]		
MP * Age	.00	− .17	.862	[.00, .00]		
Gender	1.16	2.86	.004	[.36, 1.95]		
MP * Gender	.00	1.56	.118	[.00, .00]		
Note: *CI* = Confidence Interval						

Results in Table 4 showed that moderate physical activity was not significantly associated with depression (*B* = .00, *p* > .05). Age was negatively associated with depression (*B* = − .11, *p* < .001). The *B*

showed that each unit rise in age was associated with a − .11 decrease in depression. The interaction of moderate physical activity and age was not significant (B = .00), indicating that age did not moderate the relationship between moderate physical activity and depression. Gender was positively associated with depression (B = 1.16, p < .01), indicating being female was associated with increase in depression. The interaction of moderate physical activity and gender was not significant (B = .00), indicating that gender did not moderate the relationship between moderate physical activity and depression. The R^2 of .05 for the model indicated that 5% of the variance in depression was explained on account of the entire variables, F (5, 851) = 8.64.

Table 5
The Hayes PROCESS Macro results for predicting depression by walking, with age and gender as moderators

Variables	***B***	***t***	***p***	**95%*CI***	R^2	***F***
Walking (W)	.00	-2.02	.054	[-.00, .00]	.05	7.96 (5, 851)***
Age	− .10	-5.18	.000	[-.14, − .06]		
W * Age	.00	− .21	.833	[.00, .00]		
Gender	1.16	2.88	.004	[.37, 1.95]		
W * Gender	.00	− .74	.460	[-.00, .00]		
Note: *CI* = Confidence Interval						

Results in Table 5 showed that walking was not significantly associated with depression (B = .00, p > .05). Age was negatively associated with depression (B = − .10, p < .05). The B showed that each unit rise in age was associated with a − .10 decrease in depression. The interaction of walking and age was not significant (B = .00), indicating that age did not moderate the relationship between walking and depression. Gender was positively associated with depression (B = 1.16, p < .01), indicating being female was associated with increase in depression. The interaction of walking and gender was not significant (B = .00), indicating that gender did not moderate the relationship between walking and depression. The R^2 of .05 for the model indicated that 5% of the variance in depression was explained on account of the entire variables, F (5, 851) = 7.96.

Table 6
The Hayes PROCESS Macro results for predicting depression by sitting, with age and gender as moderators

Variables	*B*	*t*	*p*	95%*CI*	R^2	*F*
Sitting (S)	− .00	-1.97	.050	[-.00, .00]	.05	8.35 (5, 849)***
Age	− .10	-5.17	.000	[-.14, − .06]		
S * Age	.00	1.07	.287	[.00, .00]		
Gender	1.25	3.11	.002	[.46, 2.04]		
S * Gender	.00	.51	.612	[-.00, .00]		
Note: *CI* = Confidence Interval						

Results in Table 6 showed that sitting was not significantly associated with depression ($B = .00$, $p = .05$). Age was negatively associated with depression ($B = -.10$, $p < .001$). The *B* showed that each unit rise in age was associated with a − .10 decrease in depression. The interaction of sitting and age was not significant ($B = .00$), indicating that age did not moderate the relationship between sitting and depression. Gender was positively associated with depression ($B = 1.25$, $p < .01$), indicating being female was associated with increase in depression. The interaction of sitting and gender was not significant ($B = .00$), indicating that gender did not moderate the relationship between sitting and depression. The R^2 of .05 for the model indicated that 5% of the variance in depression was explained on account of the entire variables, $F(5, 849) = 8.35$.

Discussion

The present study investigated the associations between PA levels (vigorous, moderate, walking and sitting) and depression, and tested whether age and gender moderates the link between PA and depression during the COVID-19 pandemic. We hypothesised as follows PA will be associated with reduced levels of depression. Based on our results, those who engaged in vigorous PA reported lower levels of depression. However, sitting, walking and moderate PA were not significantly associated with depressive symptoms. Previous research (e.g., Lin et al., 2020) had reported that moderate PA was robustly associated with depressive symptoms among China. Our current finding suggests that engagement in vigorous intensity PA may be helpful to Nigerian adults in order to reduce the potential risks of depression. The lack of a significant relationship between sitting and depression in our study is consistent with Li et al.'s report of a non-significant association between sedentary and depression. The current finding is inconsistent with the social withdrawal hypothesis, which suggests that sedentary behaviours might be linked to increased depression risks because of reduced social interactions (Kraut et al., 1998). Perhaps, sitting was not associated with depression in this study because in ana era of COVID-19 pandemic, withdrawal from some forms of social activities and distancing were public health advisories aimed at reducing the risks of COVID-19 infections.

As we hypothesized, older participants reported less symptoms of depression. Our finding is inconsistent with previous research showing that age was not related to depression (Qiu et al., 2020) but it supports previous work suggesting that in response to the pandemic older adults may have some mental health advantages (O'Connor et al., 2021; Wang et al., 2020). Despite the disproportionately at a higher risk of morbidity and mortality in this age group compared to the younger age group (Shahid et al., 2020), older adults may face lesser stressors compared to the younger people whose life course may have been changed unexpectedly by the disruptions of the pandemic. For the younger persons, their academic, social, occupational and economic prospects were likely to be more affected by COVID-19, which may partly account for their higher symptoms of depression. Older persons also tend to have less social engagements than younger ones, and so may be less severely affected by the social restrictions due to the pandemic and lockdown. The engagements of young people in social media and other emerging news outlets might also entail greater consumption of COVID-19 pandemic related news, which may increase their mental distress. Young adults also seem to have fewer available coping resources than their older peers do, and are therefore relatively disadvantaged with regard to using life experiences to develop effective coping strategies (Carstensen et al., 2020; Minahan et al., 2021; Settersten et al., 2020). Older persons are more likely to have experienced various major life events in the past, and may have lived through past public health emergencies, and thereby become more resilient. Ours is the first study using data from Nigeria during the pandemic to provide evidence of poorer mental health among younger adults compared to older persons.

It was hypothesised that women would report higher symptoms of depression than men. Consistence with previous studies (e.g., Hou, 2020; Idowu et al., 2022) our finding showed that women had higher depressive symptoms compared to men. Even though the pandemic affected both men and women, it is possible that women were more severely affected by the challenging situations of covid-19. The inclination to nurture others may entail more worries on the part of women about meeting the needs of their family and greater fear of family members COVID-19 infections by their family members. Women are more emotional in nature than men and this may mean that they may be more expressive of their emotional states than men who tend to inhibit the expression of certain emotions, and less inclined to disclose some of their feelings.

The key central objective of this study was to investigate how age and gender may modify the relationship between PA and depression. We expected that PA would be more strongly associated with less depression for older adults compared to younger adults. Age did not moderate the relationships of the PA levels and depression in the present study. Although this finding contradicts previous evidence of gender based influence of PA on COVID-19-related emotions (e.g., Alsalhe et al., 2020), it aligns with findings meta-analyses (Conn, 2020; Gordon et al., 2018) which did not find such effects.

We also hypothesised that gender will moderate the link between PA and depression, such that PA will be more strongly associated with less depression for men compared to women. Our results showed that gender did not moderate the relationships of PA and depression. This finding is consistent with the results of a number of studies which has shown that for both men and women, engaging in vigorous PA was

associated with a lower depression score (e.g., Conn, 2020; Gordon et al., 2018; Marques et al., 2020). Vigorous PA is beneficial in reducing depression score for both men and women. We suggest that PA should be included ias part of the cognitive behavior therapy (Ho et al., 2020) and psychoeducational programmes (Tran et al., 2020a, b) aimed at improving mental health during public health emergencies.

Limitations of the study and Future Directions

First, our study is cross-sectional which did not provide evidence of a temporal order among variables in our models and thus we do not claim causal relations of the variables. For instance, it is possible that those who were more depressed will be more likely to engage in less vigorous PA. Second, our study focused on depression as indicators of mental health status. Third, responses to the online survey were self-reported which may have resulted in over- or under-estimation of PA and depression. We were unable to record the number of potential respondents that were approached and how many of them decided not to participate. Lastly, we conducted the survey more than one year after the onset of the pandemic. This may have provided an opportunity to investigate the chronic mental health impact of the epidemic, but the acute real time early impacts were not examined.

Longitudinal research with large sample sizes should will provide a better understanding of long term/causal effects regarding the connection between PA and depression. More components of mental health status could be assessed in the future to investigate the impact of PA on a broader range of mental wellbeing outcomes and their differential associations across different age groups and gender. Future researchers should examine the role of PA amount, intensity and frequency on the association with depression. The use of less biased and more objective measurements of PA and depression (e.g., accelerometers and clinician administered interviews) would also be worthwhile.

Conclusion

Notwithstanding these limitations, the study has some notable strengths. One of the major strengths is the use of data obtained from adults in an era of covid-19 pandemic from a non-western culture. This is relevant to provide evidence to policymakers with regard to PA and mental health. We believe our study has made an original contribution to the literature on PA and mental health by also considering the moderating roles of age and gender during the COVID-19 pandemic. As the world emerges from the pandemic, we hope future research continues to assess how demographic factors may strengthen or weaken the impacts of physical/social engagements on mental health.

Declarations

Data Availability Statement:

The datasets generated during the current study are not publicly available due to the personally sensitivity information they contain and would compromise the privacy of research participants. However, the

datasets that support the findings are available from the corresponding author on reasonable request.

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