Original Research Article

SAGE Open Medicine

SAGE Open Medicine
Volume 10: 1–13

DOI: 10.1177/20503121221088808
journals.sagepub.com/home/smo
SAGE

Physical activity domains, levels, and health-related quality of life among Nigerian adolescents during the coronavirus disease 2019 pandemic

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Abstract

Introduction: The coronavirus disease 2019 pandemic spurred unprecedented public health measures to curb its spread. Such measures might have negatively impacted adolescents' participation in physical activity and health-related quality of life. However, the evidence is unclear in Nigerian adolescents. This study assessed the physical activity domains, levels, and health-related quality of life in Nigerian adolescents during the coronavirus disease 2019 pandemic.

Methods: The sample consisted of 430 students in public secondary schools in Nsukka, Enugu State. The students were randomly selected to participate in the cross-sectional study between November 2020 and April 2021. The Demographic Profile Form, International Physical Activity Questionnaire, Short Form-36 Health Survey, and Perceived Susceptibility to coronavirus disease 2019 Infection Questionnaire were used for data collection. Descriptive statistics, Chi-square test, independent-samples *t*-test, univariate ANOVA, and multiple linear regressions were conducted using SPSS version 25.

Results: The mean score of total physical activity (MET-min/week) was 1651.3 ($SD = 842.18$). The mean overall score of health-related quality of life was 78.30 ($SD = 16.43$). The mental health component of health-related quality of life showed that adolescents had poor mental health status. Female adolescents had higher mean scores in physical component summary ($M = 83.03$; $SD = 27.36$) and mental component summary ($M = 51.19$; $SD = 8.69$) than the male adolescents, physical component summary ($M = 69.0$; $SD = 21.65$) and mental component summary ($M = 46.15$; $SD = 10.71$).

Conclusion: The findings showed a significant positive association among gender, class of study, parental type, perceived susceptibility to coronavirus disease 2019, and physical activity domains, levels, and health-related quality of life. In addition, boys had a higher mean score of total physical activity (MET-min/week) than the girls. More girls were less active than the boys. However, concerning the health-related quality of life, girls had higher mean scores in physical component summary and mental component summary than boys. Physical activity interventions that specifically target female adolescents' physical activity participation are needed. Also, mental health interventions are needed to improve the mental health status of adolescents, especially boys in the post–coronavirus disease 2019 era.

Keywords

Physical activity, health-related quality of life, adolescents, COVID-19, Nigeria

Date received: 4 September 2021; accepted: 3 March 2022

Introduction

The novel coronavirus disease 2019 (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is a strong risk factor for poor physical and mental health outcomes. COVID-19 has spread swiftly and relentlessly to many nations of the world.[1] In a desperate bid to slow the transmission of the virus, many governments across the globe imposed lockdown or confinement measures. Although confinements are an excellent public health response to the pandemic, the lockdown measures have resulted in extensive social isolation with dire consequences

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for the mental health of diverse groups in many nations, including Nigeria.[2]

In Nigeria, the index case was confirmed on 27 February 2020 (Nigeria Centers for Disease Control (NCDC), 2020),[3] and 3 months later, the cumulative cases had risen to 22,614. The Nigerian government responded to the threat of COVID-19 by imposing lockdown measures and stay-at-home order on 30 March 2020. Schools, companies, and nonessential public services were shut down. The closure of schools due to lockdown measures implies that millions of Nigerian adolescents were physically and largely socially isolated from their friends, especially those without smartphones or Internet connections. However, given the laxity in COVID-19 restriction measures in many Nigerian communities including the study area and the need for survival, adolescents may have continued to engage in many activities such as trading, farming, and other recreational activities. Thus, the impact of COVID-19 lockdown measures on physical activity (PA) participation may vary substantially from one region to another. The findings in developed countries such as the United States, Canada, China, Italy, Brazil, and the United Kingdom should not be entirely extrapolated in the Nigerian context. Therefore, assessment of PA behavior in Nigeria during the pandemic is warranted and may provide unique insight into the impact of the pandemic on developing nations.

Adolescents constitute one of the most vulnerable groups under the COVID-19 confinement measures in Nigeria. In adolescents, the COVID-19 confinements may also promote loneliness and social isolation, thus increase poor mental health outcomes such as depression and anxiety.[2,4,5] Also, COVID-19 confinements can lead to poor quality of life,[6] and physical inactivity or sedentary behavior among adolescents.[7,8]

Studies have reported a positive relationship between PA and mental health domains in adolescents.[7,9] PA is "any bodily movement produced by skeletal muscles that result in energy expenditure."[10] The World Health Organization (WHO)[11] recommends that adolescents under 18 years engage in 60 min of moderate-to-vigorous intensity physical activity (MVPA), mostly aerobic for the week. The WHO further recommends that persons aged 18 years or older should accumulate at least 150–300 min of moderate-intensity PA (MPA) or 75–150 min of vigorous-intensity PA (VPA) per week, or a corresponding integration of both domains.[11] Also, adolescents should accumulate vigorous-intensity aerobic activities, including strengthening muscle and bone for at least 3 days/week; limit the amount of time spent on sedentary behaviors.[11] However, before the COVID-19 pandemic (i.e. prepandemic era), the overall PA levels of young adults appeared to be declining,[12] only 37% of Nigerian youths adults met the recommendations.[13] Also, 59% engaged at moderate levels, and 3.8% engaged in low levels of PA.[14,15] Prolonged stay-at-home orders without any organized PA or free play time outdoors could adversely affect body composition and cardiovascular fitness.[12,16]

The outbreak of the COVID-19 pandemic and imposition of restriction measures could suggest that engagement in domains of PA and PA levels might have declined significantly in Nigerian adolescents. Nevertheless, evidence to confirm this assumption remains unclear. Thus, one of the study's objectives was to determine the PA domains and their levels among adolescents during COVID-19 confinement in Nigeria.

Furthermore, the COVID-19 pandemic lockdown could negatively impact adolescents' health-related quality of life (HRQoL). Quality of life (QOL) is a significant indicator or measure of an individual's condition. The HRQoL comprises numerous spheres of subjective experience such as physical ability, psychological well-being, social interactions or social functioning, and school or work performance.[17] The HRQoL of adolescents is strongly linked to improved physical and mental health status. However, studies have indicated limited data on the association between PA and HRQoL among healthy populations, including adolescents.[18,19] A previous study has reported that social contacts or networks can positively affect health and well-being.[20] The disruption of social networks due to the COVID-19 confinement might have negatively impacted the HRQoL of adolescents. Thus, evaluation of HRQoL during the COVID-19 pandemic confinement could help initiate effective strategies to improve adolescents' overall well-being in Nigeria's postpandemic era. Also, there is a need for data-driven evidence to inform valid responses to the COVID-19-related adolescent mental health problems in Nigeria. This can help mitigate the possible adverse mental health outcomes of the COVID-19 pandemic.

Several factors have been linked with PA participation, levels, and HRQoL in adolescents. Such factors include personal demographic factors such as age, gender, and body mass index (BMI).[21,22] However, limited or no evidence exists on the relationship among PA domains, levels, HRQoL, and BMI among adolescents in sub-Saharan Africa, including Nigeria.[23–25]

The present study investigated PA domains, levels, and HRQoL among in-school adolescents during the COVID-19 lockdown. Second, we assessed whether the association between PA domains, levels, and HRQoL varies by adolescents' sociodemographic characteristics and perceived susceptibility to COVID-19 infection. We hypothesized that adolescents' participation in PA domains and levels during COVID-19 confinement reduced drastically and could contribute to either poor HRQoL or physical or health components of HRQoL in adolescents. Therefore, this study aimed to identify if the 3-month COVID-19 lockdown negatively impacted PA domains, levels, and HRQoL outcomes, using cross-sectional data in a sample of Nigerian adolescents.

Methods

Study design, area, population, and data collection

This school-based cross-sectional study was conducted from December 2020 to April 2021. As stated earlier, a nationwide lockdown was imposed on 30 March 2020. The first lockdown phase lasted for 3 months (April to June 2020). Subsequently, there were partial lockdowns in Lagos State, Federal Capital Territory, Abuja, Ogun, and Kano states, which were the epicenters of COVID-19 transmission in Nigeria. Schools were reopened across Nigeria in October 2020. The data collection commenced in December 2020 and ended in April 2021. During this period, Nigeria experienced the second and third waves of COVID-19. Although nationwide lockdown was not imposed, strict adherence to COVID-19 preventive protocols/nonpharmaceutical interventions was emphasized by NCDC, and COVID-19 vaccination was implemented. The study was conducted in Nsukka Local Government Area (LGA), Enugu State. The population for this study consisted of all secondary schools (junior secondary school (JSS) 1 to senior secondary schools (SSS) 3) in Nsukka LGA in Enugu State. Also, the population for this study comprised 8987 JSS students and 6777 from 30 public secondary schools in Nsukka LGA.[26] Furthermore, the PPSMB data showed 4245 and 4742 male and female students, respectively, in JSS. Also, there are 3204 and 3573 male and female students in SSS.[26]

Procedure

All the participants provided written informed consent before the study. Participants aged 18 years and above (i.e. 18+) provided written informed consent. Also, the parents/legally authorized representatives of minor subjects (i.e. those below the age of 18 years) provided written informed consent prior to the participants' involvement in the study.

The researchers ensured that the participants adhered strictly to the COVID-19 prevention protocols established by the NCDC,[27] such as wearing face masks, handwashing, and a social distance of 2 m apart during the data collection phase. Participants aged 11–19 years were included in the study. Students who complied with the COVID-19 preventive protocols were included in the study. Adolescents with health problems or those who were ill were excluded from the study. Similarly, those who did not provide written informed consent were excluded from the study. The paper–pencil format was used to collect data from the participants.

Sample size and sampling procedures

The required sample size was estimated using Cochran's sample size determination formula, $n=(Z^2\times p\ (1-p)/e^2)$. The following statistical assumptions were considered; the prevalence of PA before COVID-19 pandemic among Nigerian adolescents, 37% ($p=0.37$) as reported by Oyeyemi et al.[14] (since there was no study conducted on PA level and HRQoL in Nigeria among adolescents during the lockdown), $Z=1.96$ (i.e. 95% confidence interval), and absolute precision or margin of error to be 5% ($e=0.05$). Using these values, the minimum sample size for the study was 358. Furthermore, a 20% nonresponse rate ($71.6\approx 72$) was added to the sample due to COVID-19 preventive protocols in the schools ($358+72=430$). Hence, the final sample size for the study was 430. The multistage sampling procedure was used to draw the sample for the study from four public secondary schools. The multistage sampling procedure included probability (a simple random sampling) and nonprobability (convenience sampling) sampling techniques. We assured the participants that participation would remain voluntary, confidential, and anonymous.

Measures

Sociodemographic characteristics

A self-administered demographic profile form was developed to collect information on five sociodemographic characteristics of the participants. The respondents were asked to indicate their current age and select their age group (10–14 and 15–19 years), gender (male and female), class of study (JSS 1, JSS 2, SS 1, and SS 2), place of residence (urban vs. rural), and parental type (both parents, single parent, foster parent, and relatives/guardians), see Appendix 1.

Physical activity

We measured physical activity using the International Physical Activity Questionnaire (IPAQ-SF) short form. The IPAQ instruments were developed by Craig et al.[28] The IPAQ is a self-report measure of PA that assesses the duration of different levels of PA for the past 7 days or a week. The short form is a dimension-based instrument. The IPAQ examines physical activity in four basic domains of PA, namely vigorous, moderate, walking, and sitting. For this study, the domains of PA categorized as vigorous include games, running, jogging, playing football, skipping, carrying heavy loads, farming activities, and trekking long distances. The domains of PA categorized as moderate include table tennis, hide and seek, tag games, hiking, carrying light loads, and housework/domestic chores or gardening. Walking included walking within the streets/neighborhoods, walking on errands, recreation, and religious activities. For each domain of PA, we assessed the students using the recommended 10 min at a time and the number of days they engaged in such physical activities in a week (i.e. 7 days). Subsequently, responses indicated in hours and minutes were converted to minutes best to represent an adolescent's engagement in PA.[28]

The PA form was assigned an intensity code in units of METs (e.g. 3.3, 4.0, and 8.0).[28] Estimation of energy expenditure was obtained by multiplying the MET score by the number of minutes spent in each activity per week. The score on sitting was excluded from the PA summary score. To achieve the health benefits of PA, WHO recommended that an adolescent should engage in at least 60 min/week of moderate-to-vigorous-intensity PA. This corresponds to 600 MET-min/week. Based on this recommendation, the in-school adolescents were classified into three groups: Low PA (insufficiently active/participants getting less than 600 MET-min/week), moderate PA/sufficiently active (600 to <3000 MET-min/week), and high PA (participants reporting more than ⩾3000 MET-min/week). The cutpoints for the categories were informed by previous studies.[11,28] The IPAQ short version has been reported to be reliable and valid.[28] The IPAQ-SF and IPAQ-LF have been validated and translated in previous Nigerian studies.[29,30] The Cronbach's alpha coefficient for the IPAQ-SF in this study was 0.60 (Supplementary File 1).

Health-related quality of life

The RAND 36-item Health Survey (SF-36 version 1.0) measures self-reported HRQoL, sponsored by the Rand Corporation.[29–33] The RAND SF-36 measures eight scales: physical functioning (PF), physical role (PR), bodily pain (BP), general health (GH), vitality (VT), social functioning (SF), emotional role (ER), and emotional well-being/mental health (MH). The alpha reliability coefficients of the subscales are as follows: physical functioning ($n=10$; $\alpha=0.65$), role physical ($n=4$; $\alpha=0.77$), bodily pain ($n=2$; $\alpha=0.60$), general health ($n=3$; $\alpha=0.53$), vitality ($n=4$; $\alpha=0.32$), social functioning ($n=2$; $\alpha=0.30$), role emotional ($n=3$; $\alpha=0.72$), and emotional well-being/mental health ($n=5$; $\alpha=0.70$). The overall Cronbach's alpha coefficient for SF-36 was 0.82 (Supplementary File 2). The SF-36 has two dimensions, a physical dimension, represented by the physical component summary (PCS), and a mental dimension, represented by the mental component summary (MCS). The SF-36 is assigned a 5-point Likert-type response option such as poor (5), fair (4), good (3), very good (2), and excellent (1) or much better (1), somewhat better (2), about the same (3), somewhat worse (4), and much worse (5). Scores for each of these scales (or dimensions) range from 0 to 100. Higher scores indicate a higher level of HRQoL. The SF-36 scores range from 0 (worst) to 100 (best). Scores can be summed together from all domains with different weightings to derive two summary scores, a physical component score (PCS) and a mental component score (MCS). The SF-36 version 2 has demonstrated adequate psychometric properties in a previous Nigerian study.[34]

Perceived susceptibility to COVID-19 infection

One question was asked to assess the subjective impact of COVID-19 confinement, or they perceived themselves susceptible to the threat of COVID-19 infection: (2) "Did you or somebody in the family/neighborhood show symptoms of COVID-19 such as difficulty in breathing, diarrhea, persistent and prolonged cough and a high fever that affected how you felt or caused fear of COVID-19 infection?" The response option includes: (a) Not at all, (b) Not very much, and (c) Quite a lot. Participants who indicated *not very much* or *quite a lot* were considered vulnerable to COVID-19 infection.

Body composition

Bodyweight (BW) was measured in triplicate and following WHO's training and international guidelines.[35] Height was measured to the nearest 0.1 cm using a Holtain wall-mounted stadiometer, and weight was measured using SECA 813 electronic scale (non-medical) to the nearest 0.1 kg. Measurement equipment was calibrated daily during the data collection phase. BMI (BW (kg)/height (m^2)) was subsequently calculated.

Quality control

A rigorous quality assurance and quality control program was adopted to ensure the study's good validity and reliability. In this study, all the data collectors were well-trained to administer standardized questionnaires for data collection. The investigators meticulously supervised the data collection procedures. Filled questionnaires were examined for completeness and correctness. The questionnaires with incomplete responses were removed and considered as non-response. Of the total 430 samples, responses from 421 subjects who completed the survey with complete information were used for data analysis.

Statistical analysis

The Kolmogorov–Smirnov normality test was performed to ascertain whether sample data were drawn from a normally distributed population.[36,37] The normality test showed a significant Gaussian distribution. The study variables' skewness (between −0.45 and 0.97) and kurtosis (between −1.30 and 1.29) values are within the normal range of +2 to −2. Continuous variables were expressed as mean and *SD*, while categorical variables such as PA levels were expressed as frequencies and percentages. Furthermore, Pearson's coefficient test was used to examine the relationship between PA domains, levels, and HRQoL and its dimensions. In addition, IPAQ-SF and SF-36 scores were compared using independent samples *t*-tests and one-way ANOVA. The PA levels of the participants were compared using the Chi-square test. Effect sizes were estimated using eta squared and partial eta squared. Before analyses, a multicollinearity test was conducted to detect a high correlation among predictor variables (i.e. ⩾0.80).[36] Analysis for multicollinearity was conducted

Table 1. Demographic characteristics of the participants.

Characteristics	*n* (%), *M* (*SD*)	
Age (years)	14.6 (1.78)	
Age group (years)	*n*	(%)
10–14	238	(56.5)
15–19	183	(43.5)
Gender		
Male	303	72.0
Female	118	28.0
Class of study		
JSS 1–2	318	(75.5)
SSS 1–2	103	(24.5)
Place of residence		
Urban	253	(60.1)
Rural	168	(39.9)
Parental type		
Both parents	318	(75.5)
Single parent	64	(15.2)
Foster parents	11	(2.6)
Relatives/guardians	28	(6.7)
BMI (kg/m^2)		
$<$18.5 (underweight)	238	(56.5)
18.5–24.99 (normal)	169	(40.1)
25.0–29.99 (overweight)	8	(1.9)
$\geqslant$30 (obese)	6	(1.4)
Perceived susceptibility to COVID-19		
Not at all	397	(94.3)
Not very much	8	(1.9)
Quite a lot	16	(3.8)

BMI: body mass index; JSS: Junior secondary school; SSS: Senior secondary school.

using the variance inflation factor (VIF) and tolerance levels. No violation of the assumptions for multicollinearity was detected. The effect sizes were interpreted using Cohen's (1988) criteria. The effect was small when $\eta^2 = 0.01$ ($d = 0.20$), medium when $\eta^2 = 0.059$ ($d = 0.50$), and large when $\eta^2 = 0.138$ ($d = 0.80$).

Multiple linear regression tests were used to assess the predictive value of demographic factors (covariates) and perceived susceptibility to COVID-19 infection on the variance of PA behaviors and HRQOL. Subgroup analysis using PA domains (vigorous, moderate, and walking), levels (low, moderate, and high), and HRQOL were included in the model. The regression model was adjusted for age, sex, class of study, place of residence, and parental type during COVID-19 lockdown measures BMI categories. The regression analyses were presented using unstandardized beta-coefficients, *t*-values, and 95% confidence intervals (CIs). All statistical analyses were performed using IBM SPSS version 25.0 (Chicago, IL). The statistical significance was set at $p \leqslant 0.05$.

Results

Sociodemographic and clinical characteristics of participants

Of the 430 schooling adolescents who enrolled for the study, 421 (97.9%) completed their responses to the questionnaire items. Thus, the missing data rate was 2.1%. The participants' ages ranged between 10 and 19 years, with a mean age of 14.6 ($SD = 1.78$). Table 1 presents the demographic characteristics of the participants. Of 421 respondents, 238 (56.5%) were aged 10–14 years, and 43.5% (183) were aged 15–19 years, 72% and 28% were males and females, respectively. Many participants were in JSSs, 318 (75.5%). Most participants reside in the urban area (60.1%) and live with both parents (75.5%) during the COVID-19 pandemic. The participants had a mean BMI of 17.9 ± 2.99 kg/m^2. More than half of the participants were underweight, 238 (56.5%). Furthermore, only a small proportion (1.9% vs 3.8%) of the participants perceived themselves as susceptible to COVID-19 infection.

Relationships among study variables

Pearson's correlation matrix showed significant positive relationships among PA levels ($r = 0.14$ to 0.81). There was a significant positive relationship between PCS and MCS dimensions of the HRQOL ($r = 0.36$) (Table 2).

Physical activity level and health-related quality of life during COVID-19

There was a significant positive relationship between PCS and MCS dimensions of the HRQOL ($r = 0.36$). Also, the mean score of total PA (MET-minutes/week) was 1651.3 ($SD = 842.18$). The mean overall score of HRQoL was 78.30 ($SD = 16.43$). The mean scores for the PCS and MCS were 72.93 ($SD = 24.19$) and 47.57 ($SD = 10.43$), respectively. This implies that participants had better physical health than mental health during the COVID-19 pandemic lockdown (Table 2). Moreover, 4.3%, 58.4%, and 37.3% of the participants had low, moderate, and high levels of PA, respectively (Table 3). When the results are segregated by gender, the boys had higher mean score of total PA (MET-min/week) than the girls (1714.9 ± 832.59 vs 1486.70 ± 848.08). Concerning domains of PA, boys had higher mean scores than girls for vigorous activities ($M = 532.4$; $SD = 353.75$ vs $M = 384.2$; $SD = 307.72$), moderate activities ($M = 529.0$; $SD = 394.06$ vs $M = 474.5$; $SD = 413.35$), and walking ($M = 653.6$; $SD = 431.51$ vs $M = 621.7$; $SD = 436.51$). However, concerning the HRQoL, female adolescents had higher mean scores in PCS ($M = 83.03$; $SD = 27.36$) and MCS ($M = 51.19$; $SD = 8.69$) than the male adolescents ($M = 69.0$; $SD = 21.65$) and MCS ($M = 46.15$; $SD = 10.71$) (Table 4).

Impact of COVID-19 on PA

Table 3 shows the univariate analysis of total/overall PA score, domains, and levels by participants' demographic

Table 2. Relationships (Pearson's *r*) between main study variables and subdomains.

Variables	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
IPAQ-SF TPA MET-min/week	–													
IPAQ-SF HPA[a]	0.81**	–												
IPAQ-SF MPA[b]	0.67**	0.23**	–											
IPAQ-SF LPA[c]	0.59**	0.14**	0.39**	–										
PF	0.01	−0.02	0.03	0.04	–									
RFP	−0.10*	−0.10*	0.02	−0.09*	0.42**	–								
RFE	−0.01	−0.07	0.03	0.05	0.32**	0.48**	–							
VT	0.09*	0.09	−0.01	0.11*	−0.14**	−0.15**	−0.29**	–						
EWB	−0.04	0.00	−0.10*	−0.01	−0.04	0.09	0.10*	−0.01	–					
SF	−0.02	0.07	−0.15**	−0.01	−0.15**	0.01	−0.12*	0.34**	0.29**	–			–	
BP	0.21	0.01	−0.10*	−0.08	0.05	0.13**	0.24**	−0.06	−0.11*	0.20**	–			
GH	0.10*	0.00	0.22**	0.05	−0.11*	−0.11*	−0.07	0.06	−0.13**	−0.02	−0.18**	–		
PCS	−0.06	−0.07	0.03	−0.06	0.76**	0.86**	0.52**	−0.17**	−0.01	−0.02	0.34**	−0.03	–	
MCS	−0.01	−0.00	−0.07	0.06	0.15**	0.39**	0.72**	0.16**	0.55**	0.47**	0.22**	−0.09	0.36**	–
Skewness	0.36	0.69	0.59	0.19	0.15	0.58	0.97	0.61	−0.45	0.12	−0.39	0.01	0.34	−0.26
Kurtosis	−0.58	−0.47	−0.76	−1.30	−0.23	−0.65	−0.26	0.61	1.29	−0.28	−1.23	−0.10	−0.75	−0.69

BP: bodily pain; EWB: emotional well-being; GH: general health; High PA/IPAQ-SF HPA[a] = ⩾3000 MET-min/week; HPA/VPA: high/vigorous physical activity; IPAQ-SF MPA[b] = ⩾600 to <3000 MET-min/week; IPAQ-SF: International physical activity questionnaire-short form; IPAQ-SF LPA[c] = <600 MET-min/week; LPA: low physical activity; MCS: mental component summary; MET: metabolic equivalent task; MPA: moderate physical activity; PA: physical activity; PCS: physical component summary; PF: physical functioning; RFE: role limitations due to emotional problems; RFP: role limitations due to physical problems; SF: social functioning; TPA: total PA MET-min/week; VT: vitality.
*$p \leqslant 0.05$. **$p \leqslant 0.01$.

characteristics and perceived susceptibility to COVID-19 infection. The results showed that boys had a higher mean score of total PA and engaged more in vigorous, moderate, and walking activities than the girls. Concerning the PA levels, boys had a higher level of PA than girls. However, more girls were less active than the boys. The comparison was significant across the activities for boys and girls. The effect sizes ranged from small to medium. Besides moderate activities, students in senior classes had a higher mean score of total PA, engaged more in vigorous and walking activities than those in junior classes. Also, senior students had higher PA levels than junior students. Junior students were also less active than the senior students. The comparison was significant across PA domains and levels for the groups.

Interestingly, adolescents with single and both parents had a higher mean score of total PA than those with other categories of parenting during the pandemic. The comparison was significant only for total PA score, vigorous activities, and PA levels. As anticipated, students with normal body weight had a higher mean score of total PA than the underweight, overweight and obese students. The comparison among the groups was only significant for PA levels. Perceived susceptibility to COVID-19 infection significantly influenced the mean score of total PA and involvement in vigorous activities among the students. Adolescents who perceived themselves as "not very much susceptible to COVID-19 infection" engaged more in PA compared to the adolescents who perceived themselves as "not at all" and "quite a lot" susceptible to COVID-19 infection. The group comparison was only significant for the mean score of total PA, vigorous activities, and PA levels (Table 3).

Impact of COVID-19 on HRQoL

Table 5 shows the univariate analysis of the mean score of HRQoL, subscales, PCS, and MCS by the participants' demographic characteristics and perceived susceptibility to COVID-19 infection. The results showed that younger adolescents aged 10–14 years had a higher mean score of HRQoL, PCS, and MCS scores than those aged 15–19. The comparison was significant across for overall mean score of HRQoL and its two dimensions. Nevertheless, the comparison was insignificant for VT, BP, and GH subscales across the groups. In addition, the results showed that girls had a higher mean score of HRQoL, PCS, and MCS than boys. The comparison was significant across the group. Also, adolescents with both parents and foster parents had a higher overall mean score of HRQoL, PCS, and MCS than those with other categories of parenting during the pandemic. The comparison was significant only for the mean score of HRQoL and PCS for the groups.

Furthermore, junior students had a higher mean score of HRQoL, mean scores of PCS and MCS than the senior students. The comparison was significant for the mean score of HRQoL, PCS, and MCS across the groups. Overweight students and those with normal body weight had a higher mean score of HRQoL, mean scores of PCS and MCS than the underweight and obese students. The comparison among the groups was only significant for MCS. Adolescents who perceived themselves as "not very much susceptible to COVID-19 infection" had a higher mean score of HRQoL more than those who perceived themselves as "not at all" and "quite a

Table 3. Univariate analysis of PA, domains, and levels by participants' demographic characteristics.

Variables	Total PA score (MET-min/week) *M* (*SD*)	PA Domains			PA levels		
		Vigorous	Moderate	Walking	LPA	MPA	HPA
		M (*SD*)	*M* (*SD*)	*M* (*SD*)	*n* (%)	*n* (%)	*n* (%)
Age group (years)							
10–14	1713.7 (909.55)	472.98 (334.27)	557.1 (436.91)	679.9 (455.98)	14 (5.9)	132 (55.2)	92 (38.7)
15–19	1570.5 (740.59)	514.08 (363.73)	457.3 (338.62)	599.1 (396.95)	4 (2.2)	114 (62.3)	65 (35.5)
t (*df*)/χ^2 (*df*)/*p*-value	*t* (419) = 1.778, 0.076	*t* = −1.203, 0.229	*t* = 2.639, 0.229	*t* = 1.936, 0.053	$\chi^2(2) = 4.406$, 0.110		
η^2	0.007	0.003	0.016	0.008	–		
Gender							
Male	1714.9 (832.59)	532.4 (353.75)	529.0 (394.06)	653.6 (431.51)	9 (3.0)	162 (53.5)	132 (43.6)
Female	1486.7 (848.08)	384.2 (307.72)	474.5 (413.35)	621.7 (436.51)	9 (7.6)	84 (71.2)	25 (21.2)
t (*df*), *p*-value	*t* (419) = 2.506, 0.013	*t* = 3.999, <0.001	*t* = 1.231, 0.220	*t* = 0.676, 0.500	$\chi^2(2) = 20.276$, <0.001		
η^2	0.015	0.040	0.003	0.001			
Class of study							
JSS 1–2	1570.2 (802.86)	447.7 (319.57)	501.6 (387.77)	618.2 (426.38)	17 (5.3)	199 (62.6)	102 (32.1)
SSS 1–2	1901.2 (912.74)	623.9 (395.39)	551.1 (434.83)	726.2 (443.52)	1 (1.0)	47 (45.6)	55 (53.4)
t (*df*), *p*-value	*t* (419) = −3.513, <0.001	*t* = −4.577, <0.001	*t* = −1.091, 0.276	*t* = −2.211, 0.028	$\chi^2(2) = 16.792$, <0.001		
η^2	0.029	0.047	0.002		–		
Parental type							
Both parents	1672.7 (849.53)	513.9 (343.24)	494.4 (400.29)	661.7 (419.37)	14 (4.4)	182 (57.2)	122 (38.4)
Single parent	1743.7 (874.47)	501.7 (408.17)	604.9 (441.66)	637.2 (492.15)	0 (0.0)	34 (53.1)	30 (46.9)
Foster parents	1056.3 (408.75)	237.3 (146.63)	385.5 (153.13)	433.6 (254.48)	1 (9.1)	10 (90.9)	0 (0.0)
Relative/guardians	1431.6 (702.93)	304.4 (174.48)	575.4 (326.83)	551.8 (475.70)	3 (10.7)	20 (71.4)	5 (17.9)
F (*df*), *p*-value	*F* (3, 417) = 2.827, 0.038	*F* = 5.278, 0.001	*F* = 1.969, 0.118	*F* = 1.478, 0.220	$\chi 2$ (6) = 17.854, <0.007		
η_p^2	0.020	0.037	0.014	0.011	–		
Place of residence							
Urban	1632.3 (823.96)	476.0 (334.25)	497.1 (400.48)	655.8 (432.40)	9 (3.6)	159 (62.8)	85 (33.6)
Rural	1679.9 (870.50)	513.2 (366.57)	538.8 (398.70)	628.0 (433.70)	9 (5.4)	87 (51.8)	72 (42.9)
t (*df*), *p*-value	*t* (419) = −0.568, 0.570	*t* = −1.054, 0.283	*t* = −1.049, 0.295	*t* = −0.645, 0.519	$\chi^2(2) = 5.200$, 0.074		
η^2	0.001	0.003	0.003	0.001	–		
BMI categories (kg/m^2)							
<18.5	1575.7 (882.47)	462.7 (357.68)	485.1 (404.36)	627.9 (446.53	14 (5.9)	147 (61.8)	77 (32.4)
18.5–24.99	1773.3 (779.53)	537.8 (334.44)	556.8 (392.82)	673.0 (415.95)	4 (2.4)	87 (51.5)	78 (46.2)
25.0–29.99	1448.0 (659.34)	419.9 (192.72)	500.0 (391.33)	528.1 (472.32)	0 (0.0)	7 (87.5)	1 (12.5)
⩾30	1507.8 (869.62)	382.8 (372.33)	454.2 (415.46)	670.8 (281.22)	0 (0.0)	5 (83.3)	1 (16.7)
F (*df*), *p*-value	*F* (3,417) = 2.043, 0.107	*F* = 1.864, 0.135	*F* = 1.107, 0.346	*F* = 0.559, 0.643	$\chi^2(6) = 14.239$, 0.027		
η_p^2	0.015	0.013	0.007	0.004	–		
Perceived susceptibility to COVID-19							
Not at all	1650.9 (845.92)	491.2 (346.24)	510.9 (407.29)	646.5 (440.94	18 (4.5)	228 (57.4)	151 (38.0)
Not very much	2558.8 (792.76)	910.0 (351.36)	791.9 (289.33)	856.9 (279.53)	0 (0.0)	2 (25.0)	6 (75.0)
Quite a lot	1208.7 (165.56)	271.9 (122.50)	443.8 (104.36)	493.1 (151.74)	0 (0.0)	16 (100.0)	0 (0.0)
F (*df*), *p*-value	*F* (3,417) = 7.051, 0.001	*F* = 9.351, <0.001	*F* = 2.203, 0.112	*F* = 1.957, 0.143	$\chi^2(4) = 16.494$, 0.002		
η_p^2	0.033	0.043	0.010	0.009	–		

All post hoc comparisons (Bonferroni's test); Low PA (<600 MET-min/week); Moderate PA (600 to <3000 MET-min/week); High/vigorous PA (⩾3000 MET-min/week).

χ^2 (*df*): Pearson's chi-square/degrees of freedom; BMI: body mass index; *df*: degree of freedom; *F*(*df*): *F*-ratio/degrees of freedom; *t* (*df*): independent-samples *t*-test and degree of freedom; η^2: eta squared; η_p^2: partial eta squared.

*$p \leqslant 0.05$.

lot" susceptible to COVID-19 infection. However, adolescents who perceived themselves as "quite a lot" susceptible to COVID-19 infection had a higher mean score of MCS than the other groups. The comparison was only significant for the mean score of HRQoL and PCS across the groups (Table 5).

Table 4. PA levels and HRQOL subscales among participants ($N = 421$).

Physical activity	*M* (*SD*)
TPA MET-min/week	1651.3 (842.18)
PA levels	
Low PA ($n = 18$)	164.3 (129.81)
Moderate PA ($n = 246$)	1211.8 (439.70)
High PA ($n = 157$)	2500.9 (572.45)
HRQoL overall	78.30 (16.43)
HRQoL subscales	
PF	78.95 (48.05)
RPF	68.17 (60.99)
REF	26.17 (33.75)
Energy/VT	67.24 (11.34)
EWB	63.32 (14.85)
SF	33.53 (15.79)
BP	72.61 (25.33)
GH	72.00 (13.44)
SF-36 component scores	
PCS	72.93 (24.19)
MCS	47.57 (10.43)

BP: bodily pain; EWB: emotional well-being; GH: general health; High PA = ⩾3000 MET-min/week; IPAQ-SF: International physical activity questionnaire-short form; Low PA = <600 MET-min/week; LPA: low physical activity; Moderate PA = >600 to <3000 MET-min/week; MCS: mental component summary; MET: metabolic equivalent task; MPA: moderate physical activity; PA: physical activity; PCS: physical component summary; PF: physical functioning; RFE: role limitations due to emotional problems; RFP: role limitations due to physical problems; SF: social functioning; TPA: total PA MET-min/week; VT: vitality.

Relationship between adolescents' characteristics, PA, HRQoL, and perceived susceptibility to COVID-19 infection

Table 6 indicates that age was inversely related with PA domains ($\beta = -310.80$, p-value $= 0.001$), PA levels ($\beta = -0.10$, p-value $= 0.112$), and HRQoL ($\beta = -3.74$, p-value $= 0.027$). Gender had a negative and significant association with PA domains ($\beta = -213.49$, p-value < 0.05) and PA levels ($\beta = -0.23$, p-value $= 0.001$). However, gender was positively and significantly related to HRQoL ($\beta = 6.59$, p-value < 0.001). Class of study increased engagement in PA domains ($\beta = 353.57$; p-value $= 0.001$) and improved PA levels ($\beta = 0.19$; p-value < 0.05) and was statistically significantly. However, the class of study was negatively and significantly related with HRQOL ($\beta = -10.00$, p-value < 0.001). Parental type increased engagement in PA domains ($\beta = 13.13$, p-value > 0.05) and PA level ($\beta = 0.05$, p-value > 0.05) but was statistically insignificant. Nevertheless, parental type improved HRQoL of adolescents during COVID-19 pandemic ($\beta = 2.88$, p-value $= 0.05$) and was statistically significant. Place of residence had a negative and insignificant association with PA domains ($\beta = -6.89$, p-value > 0.05), PA levels ($\beta = -0.04$, p-value > 0.05) and HRQoL ($\beta = -2.76$, p-value $= 0.003$). However, the place of residence was significantly related to HRQoL. The BMI was positively related and increased engagement in PA domains ($\beta = 97.26$), improved PA level ($\beta = 0.06$) and HRQoL of adolescents ($\beta = 0.83$, p-value > 0.05). However, it was statistically insignificant. Perceived susceptibility to COVID-19 infection reduced PA domains ($\beta = -78.01$, p-value > 0.05) and PA levels ($\beta = -1.59$, p-value > 0.05) among adolescents. In contrast, perceived susceptibility to COVID-19 infection had a positive and significant association with HRQoL ($\beta = 7.11$, p-value < 0.001) (Table 6).

Discussion

Main findings

Our results showed that most adolescents engaged in different PA domains, especially moderate activities. Also, the majority of adolescents had moderate PA levels. Since the COVID-19 pandemic lockdown led to school closures and nonparticipation in organized physical education (PE) classes, one would have expected low participation in physical activities and a reduced PA level among the adolescents. When compared with the pre-pandemic PA levels as reported by Adeniyi et al.[13] and Oyeyemi et al.,[14] the participants reported higher levels of PA. In this study, 58.4% and 37.3% of the participants reported moderate and high PA levels. Thus, this finding was not anticipated. Nevertheless, the finding is consistent with previous studies.[14,38] The finding can be explained by poor adherence or non-adherence to the COVID-19 lockdown measures in the study area (Nsukka, Enugu State) compared to other cities such as Lagos, Abuja, Kano, Ogun, and Rivers States (these cities were the epicenters of COVID-19 infections in Nigeria). In these cities, the law enforcement agencies such as the Nigeria Police and Nigerian Security and Civil Defense Corps (NSCDC) enforced the lockdown measures. Another factor could be due to "quarantine fatigue." To overcome "isolation fatigue" associated with prolonged COVID-19 lockdown, adolescents in a bid to mitigate the impact of COVID-19 isolation might have utilized the extended period of the absence of academic activities to engage more in physical activities.

Furthermore, our results showed that boys participated more in moderate-to-vigorous activities (MVPA) and had higher PA levels than the girls during the COVID-19 pandemic. This finding agrees with prior research.[39–41] It is conventional knowledge that boys engage more in MVPA and use more facilities and equipment for organized sports and exercise than girls. The lockdown period could provide ample time for boys to engage more PA, while the girls may be involved more in light indoor and outdoor activities and domestic chores. This situation can help explain why boys engaged more in MVPA and had higher PA levels than the girls. Therefore, specific public health interventions that target improved girls' participation in PA should be implemented. For instance, community-based interventions, which include providing adequate sports facilities and equipment

Table 5. Univariate analysis of HRQoL overall score and dimensions by participants' demographic characteristics.

Variables	HRQoL overall score, *M* (*SD*)	Dimensions of HRQoL									
		PF *M* (*SD*)	RPF *M* (*SD*)	REF *M* (*SD*)	VT *M* (*SD*)	EWB *M* (*SD*)	SF *M* (*SD*)	BP *M* (*SD*)	GH *M* (*SD*)	PCS *M* (*SD*)	MCS *M* (*SD*)
Age (years)											
10–14	82.13 (15.04)	85.76 (44.41)	74.67 (57.15)	34.19 (33.97)	66.72 (10.92)	65.21 (14.30)	31.58 (14.42)	72.72 (25.14)	70.93 (12.88)	75.2 (20.18)	44.43 (9.60)
15–19	73.32 (16.85)	70.09 (51.19)	51.53 (53.27)	15.74 (30.53)	67.91 (11.86)	60.87 (15.22)	36.06 (17.14)	72.47 (25.66)	73.39 (14.04)	65.82 (21.30)	45.15 (10.97)
t (*df*)	*t* (419) = 5.654	*t* (419) = 3.357	*t* (419) = 4.242	*t* (419) = 5.772	*t* (419) = −1.061	*t* (419) = 2.998	*t* (419) = −2.912	*t* (419) = 0.099	*t* (419) = −1.872	*t* (419) = 4.624	*t* (419) = 4.261
p-value, η^2	<**0.001**, 0.07	**0.001**, 0.03	<**0.001**, 0.04	<**0.001**, 0.07	**0.289**, 0.002	**0.003**, 0.02	**0.004**, 0.02	**0.921**, 0.00	**0.921**, 0.008	<**0.001**, 0.05	<**0.001**, 0.04
Gender											
Male	75.60 (15.48)	74.04 (42.58)	58.04 (55.43)	19.35 (10.70)	68.58 (11.75)	62.88 (16.07)	33.80 (17.09)	69.68 (26.35)	72.26 (13.39)	68.01 (19.71)	46.15 (10.71)
Female	85.25 (16.82)	91.54 (58.19)	81.47 (56.34)	43.67 (35.02)	63.78 (9.41)	64.46 (11.09)	32.84 (11.90)	80.12 (20.81)	71.35 (13.58)	79.20 (22.72)	51.19 (8.69)
t (*df*)	*t* (419) = −5.604	*t* (419) = −3.397	*t* (419) = −3.877	*t* (419) = −7.010	*t* (419) = −1.146	*t* (419) = −0.981	*t* (419) = 0.561	*t* (419) = −3.859	*t* (419) = 0.625	*t* (419) = −5.007	*t* (419) = −4.553
p-value, η^2	<**0.001**, 0.07	**0.001**, 0.03	<**0.001**, 0.04	<**0.001**, 0.11	<**0.001**, 0.003	**0.327**, 0.002	**0.575**, 0.002	<**0.001**, 0.03	**0.533**, 0.00	<**0.001**, 0.10	<**0.001,** 0.10
Type of parent											
Both parents	79.41 (15.77)	84.28 (46.00)	66.92 (57.04)	27.60 (14.43)	66.88 (11.83)	63.82 (15.96)	33.59 (17.36)	70.68 (25.68)	71.74 (13.40)	72.39 (20.53)	47.97 (11.19)
Single parent	74.78 (16.28)	65.38 (51.06)	50.99 (45.86)	21.76 (14.82)	67.39 (10.29)	62.50 (7.47)	34.90 (7.10)	85.39 (22.18)	69.14 (11.12)	67.15 (21.15)	46.64 (7.64)
Foster parents	93.21 (6.28)	85.36 (48.00)	73.64 (23.35)	52.91 (19.26)	66.06 (10.09)	62.42 (13.36)	23.49 (21.02)	55.00 (20.17)	84.66 (7.05)	89.55 (6.91)	51.22 (3.89)
Relative/guardians	67.92 (19.98)	40.96 (50.31)	50.29 (69.61)	9.46 (1.79)	71.43 (7.23)	60.00 (16.92)	33.63 (4.23)	72.23 (23.32)	76.56 (16.89)	58.90 (24.79)	43.63 (7.29)
p-value, η_p^2	<**0.001**, 0.06	<**0.001**, 0.07	<**0.002**, 0.034	**0.001**, 0.037	**0.233**, 0.01	**0.576**, 0.004	**0.177**, 0.01	<**0.001**, 0.06	**0.001**, 0.04	<**0.0001**, 0.05	**0.096**, 0.02
Class of study											
JSS 1–2	81.41 (16.48)	82.16 (50.10)	73.20 (59.28)	32.65 (25.06)	66.88 (11.02)	64.15 (13.97)	34.22 (14.65)	75.00 (25.27)	71.83 (13.44)	74.29 (21.58)	49.48 (9.57)
SSS 1–2	68.71 (12.03)	69.04 (39.68)	38.08 (26.49)	6.15 (4.25)	68.35 (12.27)	60.77 (17.09)	31.39 (18.82)	65.24 (24.22)	72.51 (13.45)	61.40 (16.50)	41.67 (10.80)
t (*df*)	*t* (419) = 7.218	*t* (419) = 2.422	*t* (419) = 5.671	*t* (419) = 7.350	*t* (419) = 3.965	*t* (419) = 2.012	*t* (419) = 1.584	*t* (419) = 3.440	*t* (419) = −.444	*t* (419) = 5.558	*t* (419) = 6.970
p-value, η_p^2	<**0.001**, 0.11	**0.016**, 0.01	<**0.001**, 0.07	<**0.001**, 0.11	**0.252**, 0.04	**0.045**, 0.01	**0.114**, 0.01	**0.001**, 0.04	**0.658**, 0.00	<**0.001**, 0.07	<**0.001**, 0.10
Place of residence											
Urban	77.25 (16.60)	76.50 (49.92)	61.75 (58.02)	26.00 (15.06)	66.53 (10.43)	62.92 (14.89)	33.17 (14.91)	74.27 (24.90)	71.39 (13.85)	70.06 (21.45)	47.16 (10.40)
Rural	79.88 (16.08)	82.63 (44.92)	68.92 (54.28)	26.42 (14.25)	68.29 (12.54)	63.93 (14.81)	34.08 (17.08)	70.12 (25.86)	72.92 (12.77)	72.77 (20.72)	48.18 (10.46)
t (*df*)	*t* (419) = −1.609	*t* (419) = −1.284	*t* (419) = −1.274	*t* (419) = −0.124	*t* (419) = −1.561	*t* (419) = −0.679	*t* (419) = −0.577	*t* (419) = 1.649	*t* (419) = −1.140	*t* (419) = −1.283	*t* (419) = −0.985
p-value, η^2	**0.108**, 0.01	**0.200**, 0.003	**0.203**, 0.003	**0.901**, 0.00	**0.119**, 0.01	**0.498**, 0.00	**0.564**, 0.00	**0.100**, 0.01	**0.255**, 0.002	**0.200**, 0.002	**0.325**, 0.00
BMI categories (kg/m^2)											
<18.5	78.59 (16.49)	79.37 (55.12)	62.18 (57.39)	30.85 (36.79)	65.79 (9.36)	65.57 (14.94)	33.12 (14.86)	75.79 (25.97)	70.04 (12.93)	70.83 (21.89)	48.84 (9.95)
18.5–24.99	77.99 (16.37)	78.41 (37.25)	68.62 (56.52)	19.22 (27.79)	69.35 (13.52)	60.32 (14.25)	33.97 (17.28)	69.04 (24.23)	74.74 (13.73)	71.79 (20.24)	45.72 (10.74)
25.0–29.99	80.53 (17.62)	82.97 (32.03)	62.50 (44.32)	45.75 (33.11)	64.17 (7.07)	65.83 (16.11)	37.50 (14.09)	63.44 (14.20)	68.75 (13.36)	69.16 (21.53)	53.31 (11.42)
⩾30	73.06 (16.66)	72.00 (42.39)	51.00 (43.43)	10.08 (20.41)	68.89 (13.11)	55.56 (10.89)	31.94 (12.27)	59.17 (26.29)	77.08 (12.91)	67.98 (21.98)	41.62 (9.78)
F (*df*)	*F* (3, 417) = 0.295	*F* (3, 417) = 0.073	*F* (3, 417) = 0.546	*F* (3, 417) = 5.431	*F* (3, 417) = 3.533	*F* (3, 417) = 4.891	*F* (3, 417) = 0.284	*F* (3, 417) = 3.342	*F* (3, 417) = 4.596	*F* (3, 417) = 0.136	*F* (3, 417) = 4.524
p-value, η^2	**0.829**, 0.002	**0.974**, 0.0005	**0.651**, 0.003	**0.001**, 0.040	**0.015**, 0.025	**0.002**, 0.034	**0.837**, 0.002	**0.019**, 0.023	**0.004**, 0.032	**0.938**, 0.0009	**0.004**, 0.032
PS to COVID-19											
Not at all	77.52 (16.37)	77.42 (48.98)	61.71 (55.76)	25.85 (33.91)	67.49 (11.25)	63.36 (15.14)	33.02 (15.95)	73.92 (25.23)	71.74 (13.41)	70.09 (21.08)	47.42 (10.58)
Not very much	92.31 (7.46)	88.59 (19.61)	65.19 (53.35)	26.38 (39.33)	72.50 (15.71)	55.00 (12.22)	32.29 (11.30)	50.63 (27.93)	63.28 (11.78)	91.92 (11.61)	46.54 (8.15)
Quite a lot	90.63 (13.33)	89.63 (29.63)	86.25 (47.87)	34.06 (27.25)	58.33 (6.67)	66.67 (17.11)	46.88 (4.17)	51.25 (5.00)	82.81 (8.69)	86.79 (15.69)	51.48 (6.19)
F (*df*)	*F* (2, 418) = 8.120	*F* (2, 418) = 3.724	*F* (2, 418) = 9.827	*F* (2, 418) = 0.455	*F* (2, 418) = 6.035	*F* (2, 418) = 1.669	*F* (2, 418) = 6.084	*F* (2, 417) = 9.601	*F* (2, 417) = 7.142	*F* (2, 418) = 9.044	*F* (2, 418) = 1.204
p-value, η_p^2	<**0.0001**, 0.037	**0.025**, 0.018	<**0.0001**, 0.045	**0.635**, 0.002	**0.003**, 0.028	**0.190**, 0.008	**0.002**, 0.028	<**0.0001**, 0.044	**0.001**, 0.033	<**0.0001**, 0.041	**0.301**, 0.006

η^2: eta squared; *p*-value, η_p^2 = partial eta squared; BMI: body mass index; BP: bodily pain; *df*: degree of freedom; EWB: emotional well-being; *F*: *F*-ratio; GH: general health; HRQoL: health-related quality of life; *M*: arithmetic mean; PS: perceived susceptibility; REF: role limitations due to emotional health problems; RPF: role physical functioning/role limitations due to physical health problems; SF: social functioning; *t* (*df*): independent-samples t-test and degree of freedom; VT: vitality.
***$p < 0.001$, **$p < 0.01$, *$p < 0.05$; *p*-values are typed in boldface.

Table 6. Multiple linear regression of participants' demographic characteristics, PA domains, levels, and HRQOL.

Variables	PA domains[c]				PA level[d]				HRQOL[e]			
	Unst: B	*t*-value	*p*-value	CI for B	Unst: B	*t*-value	*p*-value	CI for B	Unst: B	*t*-value	*p*-value	CI for B
(Constant)	1863.08	6.52	<0.001	1301.30, 2424.87	2.54	13.67	0.001	2.17, 2.90	78.51	15.43	<0.001	68.51, 88.51
Age (years)[a,b]	−310.80	−3.28	0.001	−497.11, −124.50	−0.10	−1.59	0.112	−0.22, 0.02	−3.74	−2.22	0.027	−7.05, −0.42
Gender	−213.49	−2.22	0.027	−402.27, −24.72	−0.23	−3.73	0.001	−0.36, −0.11	6.59	3.86	<0.001	3.24, 9.96
Class of study[a,b]	353.57	3.43	0.001	150.70, 556.44	0.19	2.90	0.004	0.06, 0.33	−10.00	−5.45	<0.001	−13.62, −6.39
Parental type[a,b]	13.13	0.16	0.873	−148.58, 174.83	0.05	0.87	0.384	−0.06, 0.15	2.88	1.97	0.050	0.00, 5.76
Place of Resid.[a,b]	−6.89	−0.13	0.895	−109.49, 95.69	−0.04	−1.09	0.274	−0.10, 0.03	−2.76	−2.97	0.003	−4.59, −0.94
BMI	97.26	1.43	0.155	−36.94, 231.46	0.06	1.40	0.162	−0.03, 0.15	0.83	0.69	0.494	−1.56, 3.22
PS to COVID-19[b]	−78.01	−0.77	0.442	−277.12, 121.10	−0.11	−1.59	0.112	−0.23, 0.03	7.11	3.94	<0.001	3.56, 10.65
R^2	0.26				0.30				0.47			
Adj R^2	0.05				0.08				0.21			

95% CI, 95% confidence interval; Unst: unstandardized; Beta-coefficients (unstandardized) are reported.
[a]Predictors: parental type, class of study, gender, placeresid, age.
[b]Predictors: parental type, class of study, gender, placeresid, age, perceived susceptibility to COVID-19.
[c]Dependent variable: PA domains.
[d]Dependent variable: PA level.
[e]Dependent variable: HRQOL.
***$p < 0.001$, **$p < 0.01$, *$p < 0.05$.

and creating recreational parks with equitable access for girls, are required. In addition, the advocacy campaigns aimed at eliminating barriers (e.g. violence against girls/women, lack of social support for girls' PA engagement, and parental perspectives) to girls' participation in sports and physical activities become necessary. Also, health education interventions that focus on changing negative parental perspectives on girls' involvement PA are needed. Since parents' perspective may influence children's PA during the pandemic,[42] such interventions can help parents allow girls to engage in adequate PA both in the school and neighborhoods.

The current study showed that adolescents had overall good HRQoL status during the COVID-19 pandemic. Although no other research exists on HRQoL among Nigerian adolescents during the pandemic to facilitate comparison of findings, a previous longitudinal study indicated that the COVID-19 pandemic harmed QoL among young people.[43] Our finding suggests the need for longitudinal studies using data during the pandemic and postpandemic periods to examine the impact of COVID-19 on HRQoL of Nigerian adolescents.

Concerning dimensions of HRQoL, adolescents had better overall physical health. However, they had poor mental health during the pandemic. Since the physical health component depends on the ability to perform daily activities, quality of sleep, and work,[5] the pandemic lockdown could allow adolescents to engage in physical activities that benefit their physical health. This could be a possible explanation for the finding.

The poor mental health reported by adolescents during the COVID-19 pandemic was anticipated.

The finding is consistent with previous research.[2,5,42,43] Against this backdrop; there is a need for the provision of mental health services that would adequately cater to the mental health needs of young people during pandemics, emergencies, and postemergency situations at the health facility, school, community, and home levels. Mental health services could be provided by mental health experts such as clinical psychologists, child psychologists, mental health educators, guidance, and counseling experts across facets of care in Nigeria. This hopefully will enable adolescents to develop mental resilience during future pandemics and attain their psychological potentialities.

Regarding gender differences in the HRQoL of the study sample, it was observed that the females had better overall HRQoL than the males. Also, the females had better PCS and MCS scores than the males. A possible explanation for this interesting finding may be that the females received more attention and support than the males during the pandemic. Similarly, parents (both parents, single, and foster), guardians, and caregivers might have considered the girl-child more vulnerable in emergencies than the males. Thus, interventions that target the improvement of the mental health status of male adolescents during or after the pandemic are needed in Nigerian communities. The findings further showed that gender was a significant predictor of HRQoL. This finding confirms previous research.[21,22] Future studies are required to clarify gender discrepancies in HRQoL and explore the relationship between gender and HRQoL in Nigerian adolescents in the postpandemic era.

Also, no significant relation was found between PA domains, levels, and HRQoL in the present study. This finding contradicts previous studies[44,45] that reported a positive correlation between PA and HRQoL in children and adolescents. Therefore, future studies, especially longitudinal research using larger samples of Nigerian adolescents, can explore the relationship between self-reported and objectively measured PA and HRQoL. Hopefully, such studies can

address selection bias and reduce overreporting of PA, which is synonymous with self-report measures of PA.

Our results showed that parental type was a significant predictor of HRQoL in our sample. The quarantine period might have improved the bonds between parents, guardians, caregivers, and young people. With uncertainties about the pandemic, many parents would have improved family ties and relationships as a viable tool for surviving the quarantine. The finding is similar to a previous study that reported an association between social relationships and HRQoL. Future studies should explore the mediating role of parental type in improving HRQoL in adolescents during emergencies.

Perceived susceptibility to COVID-19 infection considerably reduced participation in PA domains among adolescents. Nevertheless, the effect was insignificant on PA levels. Our results showed that more than half of the participants engaged in MVPA. A possible explanation could be the closures of schools that led to fewer academic activities. In addition, adolescents may have engaged in work, domestic chores, active transport in performing errands, farming, or commercial activities to improve survival during the quarantine period. Coincidentally, the quarantine period was the beginning of the farming season in many rural communities in Nigeria. Hence, many adolescents with parents or caregivers would have engaged in farming or commercial activities to survive the economic hardships associated with the pandemic period. Therefore, many adolescents in rural communities, including those in the current study, might have acquired more MVPA during the period. This finding is inconsistent with prior research, which reported a percentage decrease in PA. Nevertheless, boys and girls engaged more in PA tasks.[12] The finding reiterates the need for urgent public health interventions by policymakers, government, physical educators, and school authorities to implement measures that can help sustain the observed PA levels among adolescents for optimal health benefits after the pandemic.

To the best of our knowledge, this is the first study to assess PA domains, levels, HRQoL, perceived susceptibility to COVID-19 pandemic, and their association in the adolescent sample in Nigeria. The use of psychometrically valid measures of PA, HRQoL, and perceived susceptibility to COVID-19 offer more comprehensive insights into these outcomes from the perspective of a developing nation. Nevertheless, some notable limitations may affect the generalizability and interpretation of findings. For instance, this study is cross-sectional; thus, causal conclusions cannot be determined. Future studies need to examine the association between PA domains, levels, HRQoL, and perceived susceptibility to COVID-19 using longitudinal data. Also, the self-report measures used in the present study are more likely to be influenced by social desirability. Thus, cautions need to be taken while interpreting the study findings.

Nevertheless, such scales are useful instruments, especially in adolescence when psychological characteristics are essential in assessing young people's perceived well-being.[46] Another limitation of the study is using a small sample size. Only the students who adhered strictly to the COVID-19 preventive protocols were included in the survey because an online survey was not feasible in the study area. Another limitation is that only schooling adolescents were included in the study. Out-of-school adolescents were not represented in the study. We recommend that future studies are required to determine whether our findings are broadly generalizable to other adolescents, such as out-of-school adolescents and orphan and vulnerable children (OVCs), as adolescents' experiences outside the school setting would likely differ considerably. A notable limitation of the study is that PA levels, HRQoL, and perceived susceptibility to COVID-19 infections were measured during the pandemic (i.e. one-time point). Thus, the analysis of PA level and HRQoL did not follow the pre-pandemic and during pandemic periods of analysis to determine if there was a change in participants' PA levels and HRQoL prior to versus during lockdown measures in Enugu State, Nigeria. Future Nigerian studies can examine changes in these variables among adolescents using during and postpandemic periods.

Furthermore, we collected study data when schools reopened (i.e. retrospective data) because many Nigerian adolescents lack access to the Internet and mobile phones. Access to the Internet or having a mobile phone would have facilitated conducting an online survey or mobile phone-based survey. For instance, the Nigerian Communications Commissions (NCC) reported that the total number of Internet subscribers in Nigeria dropped by 10.9 million in 11 months. The NCC data further indicated that the total number of Internet subscribers fell to 140.4 million in November 2021, from 151.3 million in January 2021 (https://punchng.com/Internet-subscribers-fall-by-10-9-million-over-nin-sim-linkage-others/). It is likely that a significant proportion of Nigerian adolescents were part of this population. Hence, the best time to collect the study data was after school re-openings regardless of the observed limitations.

Finally, we recommend that quality and adequate mental health services be provided for adolescents at the health facility, school, and community level to ameliorate the negative impacts of the COVID-19 pandemic on their mental health. In collaboration with mental health experts, the government should make adequate financial and human resources available to improve the mental health status of adolescents in postpandemic Nigeria.

Practical implications

The current study's findings may inform appropriate school-based mental health interventions by public health experts, school administrators, and teachers regarding adolescents' PA levels, HRQoL, and perceived susceptibility to COVID-19 in a developing nation. This study may also help the general public, teachers, school administrators, and government agencies such as Ministries of Health and Education identify the need to scale up efforts to improve the mental health status of children and adolescents, especially in the school environment

during and after the pandemic. Furthermore, given the likely resurgence or a possibility of COVID-19 third wave in Nigeria, stakeholders should make concerted efforts (government, agencies, and corporate bodies) to ensure that adequate resources are provided to mitigate the effects of COVID-19 on children and adolescents' mental health.

Conclusion

This study was the first to examine adolescents' PA domains, levels, HRQoL, their perceived susceptibility to COVID-19, and associations during COVID-19 confinement in Nigeria. Our findings showed that adolescents, irrespective of gender, acquired moderate and high PA levels during the pandemic period. The PA levels were higher than those reported by previous studies before the COVID-19 pandemic period in Nigeria. Similarly, they had a good HRQoL overall score. However, they had poor mental health status during the COVID-19 confinement.

Furthermore, a small proportion of adolescents perceived themselves as susceptible to COVID-19 infection. Gender differences were found in the PA domains, levels, and HRQoL. Gender, class of study, parental type, and perceived susceptibility to COVID-19 infections were associated with PA domains, levels, and HRQoL among the participants. The findings are significant for public health and school mental health interventions that focused on improving PA participation for optimal health benefits and mental health status among Nigerian adolescents in the post-pandemic era.

Acknowledgements

The authors would like to thank the Research Ethics Committee (REC) of the Faculty of Education, University of Nigeria, Nsukka, for facilitating this study. Also, the authors thank all the study participants. The authors would like to thank all the principals of selected schools, Physical and Health Education (PHE) teachers, subject headteachers, and research assistants who assisted during the data collection phase.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Ethical approval

The permission to conduct the study was obtained from each secondary school, and the study was approved by the Institutional Review Board (IRB) of the Faculty of Education, the University of Nigeria, Nsukka (Ref #: UNN/FE/REC21/011).

Informed consent

Written informed consent was obtained from all subjects before the study. All the participants provided written informed consent before the study. Participants aged 18 years and above (i.e. 18+) provided written informed consent. Also, the parents/legally authorized representatives of minor subjects (i.e. those below the age of 18 years) provided written informed consent prior to the participants' involvement in the study.

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Supplemental material

Supplemental material for this article is available online.

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