Physical activity during covid-19 lockdown: Relationship with sedentary behaviour, health-related quality of life, loneliness, and sleep quality among a sample of Nigerian adults

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Abstract

COVID-19 lockdown, targeted at preventing the spread of coronavirus, had deleterious effects on physical and psychosocial health. This study examined the association between physical activity (PA), sedentary behaviour, health-related quality of life (HRQoL), loneliness and quality of sleep of 507 Nigerian adults during the COVID-19 lockdown. Five hundred and seven respondents (aged 18-67 years) from 12 States completed an online survey on RedCap. Questionnaires comprising the Stages of Change scale, Pittsburgh Sleep Quality Index, International Sedentary Assessment Tool, UCLA Loneliness Questionnaire, Short Form-12 Health Survey, and International Physical Activity Questionnaire were used. Respondents were categorised based on exercise behaviour as non-exercisers, non-regular exercisers, or regular exercisers; and based on age into 18-24, 25-34, 35-44 and > 44 years categories. Descriptive and inferential statistics were used to analyse the data. About 33.1% of respondents did not meet moderate-to-vigorous PA levels. The physical component of HRQoL was positively associated with total PA (p = 0.04). Among the non-exercisers, the odds of being regular exercisers during pre-COVID-19 lockdown were significantly higher for the 35-44 (odds ratio [OR] = 3.49; 95% CI = 1.44, 8.48, p = 0.01) and > 44 years age groups (OR = 2.98; 95% CI: 1.16, 7.62, p = 0.02) relative to 18-24 years age category. During COVID-19 lockdown, > 44 (OR = 3.65; 95% CI: 1.47, 9.07, p = 0.005), 35-44 (OR = 6.42; 95%CI 2.75, 14.96, p = 0.001) and 25-34 (OR = 2.35; 95% CI: 1.15, 4.80, p = 0.02) years age categories had significant higher odds of being regular exercisers compared to the 18-24 years age group. There was a high rate of physical inactivity among Nigerian adults during the COVID-19 lockdown, which was directly influenced by the physical components of HRQoL. Older age was an independent predictor of exercise behaviour before and during the COVID-19 lockdown among Nigerian adults.

Keywords*:* COVID-19, physical activity, exercise behaviour, quality of life, Nigerian adults.

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Introduction

The coronavirus (COVID-19) is highly contagious. It is a peculiar respiratory disease-causing virus which may remain asymptomatic for about 2-10 days in an infected individual (Guan *et al.*, 2020). The virus is spread among humans when a non-infected individual encounters surfaces infected by contaminated aerosols from sneezes and coughs of carriers (van Doremalen *et al.*, 2020). Further, transmission to humans is possible when an individual inhales airborne-infected particles produced from the sneezes or cough of a carrier or when such particles come into contact with the mucosal membrane of the eyes.

Symptoms of COVID-19 include dyspnoea, dry cough, fever, and fatigue. These symptoms range from mild to moderate (in about 80% of cases), severe requiring oxygen (15%) and critical cases (about 5%), which require continuous ventilation and life support (Guan *et al.*, 2020). Increased mortality in individuals with comorbidities or older people with this disease is common. As of May 26, 2022, 524,878,064 cases of COVID-19 were confirmed, resulting in 6,283,119 deaths globally (World Health Organization, 2022). In Africa, coronavirus disease has affected over eight million people and resulted in 172,442 deaths. Nigeria has the ninth-highest number of deaths (3,143) in Africa, with 255,972 confirmed cases. Various strategies, including the interruption of human-to-human transmission, prevention of both transmission amplification events and further international spread, were suggested as temporary mitigation measures to contain the pandemic. All these prevention measures may be achieved through proper hand hygiene, social distancing, total and subsequently local or partial lockdown of activities in endemic regions, implementation of health measures for travellers and adherence to safety precautions in health care settings. Thus, most nations of the world, including Nigeria, have adopted these preventive measures; however, such steps are not without adverse effects on people's health and overall quality of life.

Restricting movement and human activities during lockdowns may reduce physical activity (PA) levels. Physical activities such as walking and jogging, commonly engaged by adults, were impacted during the COVID-19 lockdown. Other activities like gym classes or group exercises were also affected by the closure of such facilities. Another related problem during COVID-19 lockdown is the adoption of sedentary behaviour which has been on the increase. Although often used synonymously, PA and sedentary behaviour are not mutually exclusive. For instance, an individual can be physically active and still be sedentary; this

phenomenon is called an active 'couch potato' (Lepp & Barkley, 2019). People who meet the required weekly PA guidelines but still accumulate sedentary behaviours can develop health problems (Biswas *et al.*, 2015). Similarly, movement restriction and social distancing may lead to increased loneliness, sleep problems and poor quality of life (QoL). Loneliness and PA are modifiable mediators of mental health and QoL; thus, paying close attention to these modifiable factors during any pandemic (Armitage & Nellums, 2020; Lapane *et al.*, 2022) is crucial.

This study was conducted to evaluate PA levels and their association with sedentary behaviour, health-related QoL (HRQoL), sleep quality, and loneliness, during COVID-19 lockdown among a sample of Nigerian adults. Additionally, we examined the perceived exercise behaviour among a cohort of adult Nigerians before and during the COVID-19 lockdown.

Methodology

Study design and sample

This online survey was carried out (from April to May, 2020) among 507 Nigerian citizens who were domiciled in the country during the COVID-19 lockdown period. Owing to the peculiarity of the COVID-19 pandemic period, the required number and list of all potential respondents in the Nigerian population could not be obtained. However, to ensure some level of spread in sampling, two states each from the six geopolitical zones were randomly selected. Focal persons (n= 37) (physiotherapists who were actively involved in physical activity research) were identified in 12 states (Abuja, Anambra, Bauchi, Edo, Enugu, Kaduna, Kano, Kwara, Lagos, Osun, Taraba, and Rivers). They were provided with phone data bundles to facilitate sharing the survey link to individuals and groups on WhatsApp® platforms they had affiliations with. The focal persons oversaw broadcasting and re-broadcasting of the survey link periodically. Also, consenting respondents shared the survey link further with their contacts and association platforms. Geographical locations of respondents are presented in the supplementary material (p. 337). Eligible respondents in the study were 18 years and older, literate in English, and owned a smartphone. Individuals with severe and debilitating health problems that could impair PA participation were advised to decline participation in the study. To prevent survey fraud, a respondent's phone number was programmed to be able to only respond to the survey once. Any other attempt from the same phone number was automatically denied. A convenience sample of the randomly selected states was used for this study.

Measures

Respondents' demographic information (age, marital status, gender, educational level) was documented using a proforma. A self-rating socioeconomic status (SES) ladder of nine rungs previously used by Mbada *et al.* (2010) was applied to assess respondents' SES. The ladder rungs were allocated minimum and maximum scores of 3 and 27 for anyone rated to be on the first and ninth rungs. Respondents with scores <9, 10-18 and>18 were categorised into the lower, middle, and higher SES, respectively. The stages of change scale comprising one question (select the statement that was closest to your exercise behaviour) was used to garner information on respondents' perceived regular exercise behaviour before and during the COVID-lockdown period (Marcus *et al.*, 1992).

Stages of change were assessed using a 5-item checklist where respondents could only choose one of 5 response alternatives. Based on the 5-item response scale of perceived exercise behaviour, the respondents were divided into non-exercisers, non-regular exercisers, and regular exercisers. Participants rated their sleep quality during the past month using a single item from the Pittsburgh Sleep Quality Index (PSQI). The four possible responses ('very good,' 'fairly good,' 'fairly poor, 'and 'very poor') were dichotomised into good and poor sleep qualities. This question is a valid and reliable measure of sleep quality (Buysse *et al.*, 1989). Sedentary behaviour of respondents was measured with a single item from the International sedentary assessment tool (ISAT) (Prince *et al.*, 2017). Respondents were asked how long they spent sitting or lying down to watch TV or use a smartphone or a computer on a typical day in the last seven days. The ISAT has satisfactory internal consistency ($\alpha = 0.8$) and validity (rho = 0.6) (Cuesta-Vargas *et al.*, 2020)**.**

The short-form version of the UCLA Loneliness Questionnaire was used to determine the loneliness levels of the study sample (Hughes *et al.*, 2015). The questionnaire comprises three questions rated on a three-point Likert scale (hardly ever =1, sometimes = 2, often = 3). The minimum obtainable score is 3, while the maximum is 9, with increasing scores indicating high levels of loneliness. Scores between 3-5 or 6-9 have been used to classify people into 'not lonely' and 'lonely' subgroups, respectively (Steptoe *et al.*, 2013). The short form of the loneliness questionnaire is reliable and valid (Hughes *et al.*, 2015). Respondents' HRQoL was measured using the short-form 12 (SF-12). The SF-12 is a generic health status instrument that assesses an individual's physical functioning, bodily pain, general health, and physical role functioning. Other dimensions of HRQoL assessed by the SF-12 include vitality, mental health, social functioning, and emotional role functioning (Ware *et al.*, 1996). Each participant's scores were computed using weighted means of the eight domains to derive a physical- and mental component summary HRQoL score. This measure (i.e., SF-12) has been found useful in clinical and research settings in the Nigerian context. This tool has also been translated into two predominantly spoken Nigerian languages and has good psychometric properties (Mbada *et al.*, 2021; Ibrahim *et al.*, 2020).

Respondents' PA levels were assessed using the International Physical Activity Questionnaire short-form (IPAQ-SF) (International Physical Activity Questionnaire, 2020). Participants indicated how many days and how long they engaged in hard, moderate, walking and sitting activities in the last seven days during the COVID-19 lockdown period. The IPAQ-SF scores were computed using standard procedures. An individual who attained a minimum of 600 MET-min/week was adjudged to engage in sufficient PA (moderate-to-vigorous PA) (MVPA)). The IPAQ-SF is reported to have good test-retest reliability and construct validity among the Nigerian population (Oyeyemi *et al.*, 2011).

Ethical considerations and procedure

The Research Ethics Committee of the College of Medical Sciences, University of Benin, Benin-City, Nigeria, approved this study (CMS/REC/168). The study recruited contact persons who were physical activity advocates (physiotherapists selected randomly from the databases of the two associations of physiotherapists in Nigeria- Physiotherapy Association of Clinical and Academic Physiotherapists of Nigeria and Nigeria society of Physiotherapy) domiciled in different geopolitical regions of the country. The contact persons assisted in the recruitment of participants for this study. Using the Redcap® software, the research instruments were hyperlinked to WhatsApp. The survey link's first page contained detailed information about the research and informed consent. The 'accept to participate' box must be checked before participants could access the questionnaire. The survey links were sent to the contact persons' WhatsApp®, who sent the links to respondents' groups inviting them to participate in the survey. At the end of the survey period, the survey link was disabled, and data were extracted for analysis. The data were collected between April and May 2020.

Statistical analyses

Descriptive statistics were calculated for categorical and continuous variables. Data for sedentary behaviour, HRQoL, loneliness, and sleep quality were (Shapiro-Wilk test $p \leq 0.05$) presented using medians and inter-quartile ranges. Physical activity was dichotomized (moderate to vigorous PA vs. insufficient PA) and also presented as means and standard deviation. We considered four relevant socio-demographic factors in our analysis: age groups (18-24, 25-34, 35-44 vs. >44 years), gender (men vs. women), marital status (married vs. not married), and socioeconomic status (SES) (lower, middle, or higher). Differences in the prevalence of MVPA according to socio-demographic factors were determined using the Chi-square (χ^2) test. Additionally, we examined the association between socio-demographic factors and PA with multiple linear regression. Multiple linear regression was conducted to determine the association between PA and sedentary behaviour, loneliness, sleep quality and HRQoL of individuals during the lockdown (while controlling for socio-demographic factors) in the total population and among males and female respondents, respectively.

Differences in the respondents' perceived exercise behaviour pre-and during the COVID-19 lockdown period were examined using the Chi-square (χ^2) test of independence. Furthermore, multinomial logistic regression models were used to assess the influence of socio-demographic attributes on respondents' change in exercise behaviour before and during the COVID-19 lockdown period. All statistical analyses were performed using IBM SPSS (version 22, Armonk, NY: IBM Corp) and alpha level was set at ≤ 0.05.

Results

Participants' characteristics and prevalence of MVPA by socio-demographics

Five hundred and twenty-four respondents participated in the survey. However, 17 responses were excluded due to incomplete information. Responses from 507 participants (30.5 ± 11.2 years) were subsequently analysed and reported. Approximately 59% (n=300) and 15% (n=77) of respondents were in the middle and lower socioeconomic classes, respectively. A total of 339 (66.9%) met sufficient MVPA levels, with more males (71.8%) meeting this recommendation than females (63.2%). However, 168 (33.1%) did not meet sufficient MVPA levels, and of these, females (37%) were more likely not to meet the recommendations than males (28%). The respondents' general characteristics are presented in Table 1.

Table 1: General characteristics of respondents (N= 507)

Characteristic	**Female (n=291) n (%)**	**Male (216) n (%)**	**Total (n=507) n (%)**	***p-value***
Age (years)				
18-24	147 (50.5)	72 (33.3)	219 (43.2)	0.001**
25-34	68 (23.4)	50 (23.1)	118 (23.3)	
35-44	48 (16.5)	52 (24.1)	100 (19.7)	
>44	28 (9.6)	42 (19.4)	70 (13.8)	
Marital Status				
Single	219 (75.3)	130 (60.1)	349 (68.8)	0.003**
Married	65 (22.3)	82 (38)	147 (29)	
Separated	2 (0.7)	1 (0.5)	3 (0.6)	
Divorced	1 (0.3)	2 (0.9)	3 (0.6)	
Widowed	4 (1.4)	1 (0.5)	5 (1)	
Educational Level				
Primary	1 (0.3)	1 (0.5)	2 (0.4)	0.71
Secondary	4 (1.4)	4 (1.8)	8 (1.6)	
Polytechnic	16 (5.5)	11 (5.1)	27 (5.3)	
University	177 (60.8)	143 (66.2)	320 (63.1)	
Undergraduate	93 (32)	57 (26.4)	150 (29.6)	
Employment Status				

Unemployed	155 (53.3)	91 (42.1)	246 (48.5)	0.03*
Employed	133 (45.7)	124 (57.4)	257 (50.7)	
Retiree	3 (1.0)	1 (0.5)	4 (0.8)	
Socio-economic status				
Lower	47 (16.1)	30 (13.9)	77 (15.2)	0.76
Middle	169 (58.1)	131 (60.6)	300 (59.2)	
Higher	75 (25.8)	55 (25.5)	130 (25.6)	
Sleep quality				
Good sleep	269 (92.4)	199 (88.4)	460 (90.7)	0.16
Poor sleep	22 (7.6)	17 (11.6)	47 (9.3)	
Met sufficient physical activity during the lockdown period				
Yes	184 (63.2)	155 (71.8)	339 (66.9)	0.03*
No	107 (36.8)	61 (28.2)	168 (33.1)	

Note: Statistical measure = Chi-square test *p<0.05; **p<0.01.

The median scores for the respondents' sedentary behaviour and loneliness were 5.0 and 7.0, respectively. Most respondents rated their sleep quality as good (90.7%) but were lonely (88.2%) during the COVID-19 lockdown. Further, 54.6% and 45.4% of respondents spent <4 hours and > 4 hours on sedentary activities. The tendency of achieving sufficient MVPA was significantly different between genders (χ^2 = 4.07, p = 0.05); but not for age (χ^2 = 5.49, p = 0.14), marital status (χ^2=0.13, p=0.76), and SES (χ^2 = 0.09, p=0.95) distributions. Male respondents had significantly higher total PA, MVPA and physical component summary of QoL scores than female respondents. While female respondents had higher loneliness scores than males, light-intensity PA, sedentary behaviour, and the mental component summary of QoL scores were not significantly different between male and females. The mean and median estimates of the respondents' PA, sedentary behaviour, loneliness, and HRQoL are presented in Table 2.

Table 2: Mean and median estimates of physical activity, sedentary behaviour, loneliness, and health-related quality of life characteristics of respondents (n= 507)

Variables	**Female (n=291) Mean [SD] or median (IQR)**	**Male (216) Mean [SD] or median (IQR)**	**Total n (507) Mean [SD] or median (IQR)**	***p-value***
Total PA (MET/week)	2262.04 [3076.85]	3491.17 [4270.53]	2785.7 [3680.36]	0.001**
Light-intensity PA (MET minutes/week)	201.7 [202.6]	257.4 [203.7]	221.9 [204.2]	0.09

Moderate-vigorous intensity PA (MET minutes/week)	3460.2 [3324.6]	4763.8 [4435.4]	4056.2 [3920.6]	0.003**
Sedentary behaviour	5 (3)	4 (3)	5 (3)	0.51
HRQoL-Physical component summary	77.5 (33.3)	82.5 (27.1)	79.2 (31.2)	0.002**
HRQoL-Mental component summary	55 (15)	53.3 (16.7)	55 (16.7)	0.2
Loneliness	7 (1)	7 (0)	7 (1)	0.02*

Note: statistical measures included independent t and Man-Whitney U tests *p<0.05; **p<0.01;
Abbreviations: PA, Physical activity; MET-Metabolic equivalent; SD = Standard deviation; IQR=Interquartile range; HRQoL= Health-related quality of life

Further, the results on respondents' MVPA across socio-demographic characteristics provided in Table 3 revealed a significant association between gender and the prevalence of achieving MVPA; other sociodemographic variables including age, marital status and SES were not significant.

Table 3: Respondents' MVPA by socio-demographic distribution (n=507)

Variable	Group	Prevalence of achieving moderate-to-vigorous physical activity		*p*-value
		Yes (%)	No (%)	
Age (years)	18-24	136 (62.1)	83 (37.9)	0.14
	25-34	79 (66.9)	39 (33.1)	
	35-44	71 (71)	29 (29)	
	>44	53 (75.7)	17 (24.3)	
Gender	Male	155 (71.8)	61 (28.2)	0.05*
	Female	184 (63.2)	107 (36.8)	
Marital status	Married	100 (68)	47 (32)	0.76
	Not married	239 (66.4)	121 (33.6)	
Socioeconomic Status	Lower	52 (67.5)	25 (32.5)	0.95
	Middle	199 (66.3)	101 (33.7)	
	Higher	88 (66.7)	42 (32.3)	

Note: The statistical measure was the Chi-square; *p < 0.05.

Associations between total PA, socio-demographic, sedentary behaviour, loneliness, sleep quality and HRQoL

The linear regression analyses on the association between total PA and socio-demographic factors, as well as between PA and each of sedentary behaviour,

loneliness, sleep quality and HRQoL of individuals during the lockdown while controlling for socio-demographic factors, are shown in Table 4. Only male gender (Unstandardized coefficient [*B*] = 1294.32, 95% confidence interval [CI]; 617.69, 1970.95) was significantly associated with total PA in model 1. In model 2, while controlling for socio-demographic variables, physical component summary HRQoL score (B = 17.92, 95% CI 1.23 to 34.61) was positively associated with total PA. As presented in Table 5, stratified analysis by gender showed that only physical-HRQoL was positively and independently associated with total PA in females.

Table 4: Multiple linear regression analysis between total PA and socio-demographic factors; (*Model 2*†) linear regression analysis between PA and sedentary behaviour, loneliness, sleep quality, and HRQoL of individuals during the lockdown.

Variables	***Model 1*† B (95% CI), β**	***p-value***	***Model 2* ł B (95% CI), β**	***p-value***
Age (years)				
18-24	Reference		Reference	
25-34	-351.77 (-1468.16 to 764.61), -0.04	0.54	-342.48 (-1462.225 to 777.275), -0.04	0.55
35-44	-522.61 (-1610 to 564.78), -0.06	0.35	-526.63 (-1615.916 to 562.666), -0.06	0.34
>44	-267.09 (-1276.48 to 742.3), -0.04	0.60	-268.36 (-1279.486 to 742.771), -0.04	0.60
Gender				
Female	Reference		Reference	
Male	1294.32 (617.69 to 1970.95), 0.17**	0.001**	1188.97 (501.376 to 1876.565), 0.16**	0.001**
Marital Status				
Not married	Reference		Reference	
Married	-530.45 (-1255.96 to 195.05), -0.07	0.15	-498.48 (-1232.067 to 235.097), -0.06	0.18
Socioeconomic Status				
Lower class	Reference		Reference	
Middle class	589.27 (-181.29 to 1359.86), 0.08	0.13	584.35 (-190.93 to 1359.64), 0.08	0.14
Higher class	-281.76 (-1340.56 to 777.04), -0.03	0.60	-257.95 (-1318.70 to 802.81), -0.03	0.63
Sleep quality				
Poor			Reference	

Good	_____	129.98 (-975.75 to 1235.72), 0.01	0.82
Sedentary behaviour	_____	46.77 (-114.52 to 208.07), 0.03	0.57
Loneliness	_____	-2.28 (-338 to 333.44), -0.01	0.99
HRQoL-Physical component	_____	17.92(1.23 to 34.61), 0.10*	0.04*
HRQoL-Mental component	_____	-3.16 (-26.41 to 20.1), -0.01	0.79

Abbreviations: B = unstandardized coefficient; β =Standardized coefficient; HRQoL= Health-related quality of life; 95% CI = 95% Confidence interval

† Model 1 included only socioeconomic factors; ł Model 2 included socioeconomic factors, sedentary behaviour, loneliness, sleep quality and HRQoL.

*p<0.05; **p<0.01.

Table 5: Subgroup multiple linear regression analysis between PA and sedentary behaviour, loneliness, sleep quality and HRQoL by gender

Variables	***Female*** **B (95% CI), β**	***p-value***	***Male*** **B (95% CI), β**	***p-value***
Age (years)				
18-24	Reference		Reference	
25-34	-165.81 (-1274.13 to 942.52), -0.02	0.77	-670.79 (-3239.85 to 1898.28), -0.05	0.61
35-44	-1083.46 (-2183.88 to 16.96), -0.15*	0.05*	418.65 (-1984.44 to 2821.74), 0.04	0.73
>44	62.60 (-995.78 to 1120.97), 0.01	0.91	-558.73 (-2706.34 to 1588.88), -0.07	0.61
Marital Status				
Not married	Reference		Reference	
Married	-548.72 (-1428.92 to 331.49), -0.07	0.22	-346.73 (-1594.02 to 900.56), -0.04	0.58
Socioeconomic Status				
Lower class	Reference		Reference	
Middle class	-39.37 (-905.95 to 827.20), -0.01	0.93	1361.58 (-43.05 to 2766.2), 0.16	0.06
Higher class	-725.82 (-1892.85 to 441.21), -0.09	0.22	494.54 (-1483.63 to 2472.7), 0.04	0.62
Sleep quality				
Poor	Reference		Reference	

Good	676.31 (-678.17 to 2030.80), 0.06	0.33	-446.38 (-2265.709 to 1372.953), -0.03	0.63
Sedentary behaviour	-71.48 (-252.43 to 109.48), -0.05	0.44	200.20 (-92.51to 492.91), 0.09	0.18
Loneliness	67.54 (-295.74 to 430.81), 0.02	0.72	-145.06 (-789.85 to 499.72), -0.03	0.66
HRQoL-Physical component	18.13 (0.23 to 36.02), 0.12*	0.05*	22.29 (-10.76 to 55.33), 0.10	0.19
HRQoL-Mental component	-5.16 (-30.76 to20.44), -0.02	0.69	-4.28 (-49.04 to 40.48), -0.04	0.85

Abbreviations: B = unstandardized coefficient; β =Standardized coefficient; HRQoL= Health-related quality of life; 95% CI = 95% Confidence interval; Model adjusted for socioeconomic factors; *p=0.05

Exercise behaviour and socio-demographics

The perceived exercise behaviour of respondents before and during the lockdown restriction is presented in Table 6. Before the COVID-19 lockdown, 53.6% of respondents were non-regular exercisers, while during the lockdown, 50.1% were non-regular exercisers (Table 6). Although not significant, the number of people who reported being regular exercisers and non-exercisers, respectively, increased during the lockdown period. Conversely, the number of individuals who reported being non-regular exercisers decreased during the lockdown period (Figure 1).

Table 6: Perceived exercise behaviour of the respondents

Exercise behaviour of respondents before the COVID-19 lockdown		
	Frequency	%
I did not exercise and did not anticipate starting in the next 6 months	58	11.4
I did not exercise, but I considered starting in the next 6 months	79	15.6
I was exercising a little but not regularly	272	53.6
I was exercising regularly but only began doing so in the last 6 months	28	5.5
I was exercising regularly and was doing so for more than 6 months	70	13.8
Exercise behaviour of respondents during the COVID-19 lockdown		
	Frequency	%
I currently do not exercise and do not anticipate starting in the next 6 months	60	11.8
I currently do not exercise, but I am considering starting in the next 6 months	89	17.6
I currently exercise a little but not regularly	254	50.1
I currently exercise regularly but have begun doing so in the last 6 months	47	9.3
I currently exercise regularly and have done so for more than 6 months	57	11.2

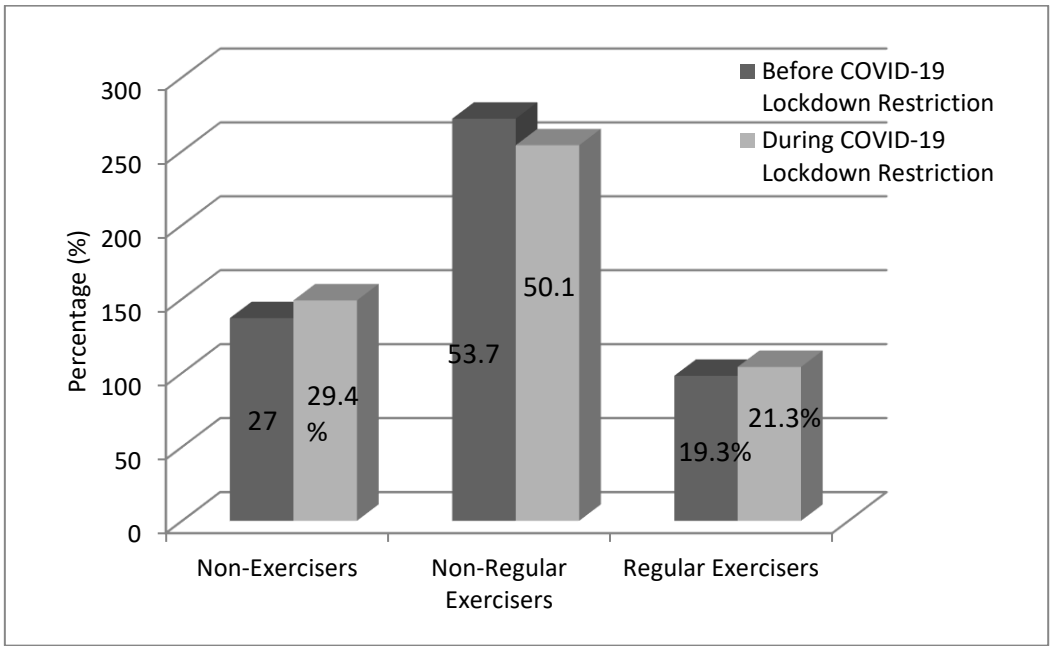

Figure 1: The proportion of non-exercisers, non-regular exercisers, and regular exercisers before and during the lockdown period.

Multinomial logistic regression analyses showed that before the lockdown period, using non-exercisers as the reference group, those who were older than 44 years (odds ratio [OR] = 0.23, 95% CI: 0.11, 0.52), 35-44 years (OR = 0.30, 95% CI: 0.14, 0.61), and 25-34 years (OR = 0.17, 95% CI: 0.10, 0.31) had significantly lower odds of reporting being a non-regular exerciser compared to those in 18-24 years age group. Also, with reference to non-exercisers, those who were married were less likely to be non-regular exercisers than the unmarried (OR = 0.55 95% CI: 0.31, 0.97).

Furthermore, regarding non-exercisers, the odds of reporting being a regular exerciser for those who were aged > 44years (OR = 2.98, 95% CI; 1.16, 7.62) and 35-44 years (OR = 3.49, 95% CI; 1.44, 8.48) were significantly higher compared to those who were aged 18-24 years (Table 7). However, with reference to non-exercisers during the COVID-19 lockdown period, those aged 25-34 years (OR = 0.35 95% CI: 0.20 to 0.61) had significantly lower odds of reporting being a non-regular exerciser compared to the age category of 18-24 years. On the other hand, those who were aged >44 years (OR = 3.65, 95% CI: 1.47,9.07), 35-44 years (OR = 6.42 95% CI: 2.75,14.96) and 25-34 years (OR = 2.35 95% CI: 1.15,4.80) had a significantly higher odds of reporting being regular exercisers compared to those in 18-24 years age group. By contrast, those who were married (OR = 0.53 95% CI: 2.72, 0.97) had significantly lower odds of reporting being regular exercisers compared to the unmarried individuals during COVID-19 lockdown.

Table 7: Multinomial logistic regression analysis on the relationship between the exercise behaviour and socio-demographic variables of respondents before and during the COVID-19 lockdown period

Variables	Non-regular exercisers[1] Odds ratio (95% CI), *p*-value	Regular exercisers[1] Odds ratio (95% CI), *p*-value
Exercise behaviour before COVID-19 lockdown		
Age (Years)		
18-24	Reference	Reference
25-34	0.17 (0.1 to 0.31), 0.001**	1.48 (0.68 to 3.23), 0.32
35-44	0.30 (0.14 to 0.61), 0.001**	3.49 (1.44 to 8.48), 0.01**
>44	0.23 (0.11 to 0.52), 0.001**	2.98 (1.16 to 7.62), 0.02*
Gender		
Female	Reference	Reference
Male	0.90 (0.57 to 1.42), 0.65	1.23 (0.72 to 2.12), 0.46
Marital Status		
Not married	Reference	Reference
Married	0.55 (0.31 to 0.97), 0.04*	0.33 (0.17 to 0.62), 0.001**
Socioeconomic status		
Lower	Reference	Reference
Middle	1.32 (0.69 to 2.53), 0.40	1.04 (0.46 to 2.33), 0.93
Higher	1.47 (0.69 to 3.14), 0.32	1.24 (0.5 to 3.09), 0.65
Exercise behaviour during COVID-19 lockdown		
Age (Years)		
18-24	Reference	Reference
25-34	0.35 (0.2 to 0.61), 0.001**	2.35 (1.15 to 4.80), 0.02*
35-44	0.74 (0.37 to 1.51), 0.41	6.42 (2.75 to 14.96), 0.001**
>44	0.54 (0.25 to 1.14), 0.10	3.65 (1.47 to 9.07), 0.005**
Gender		
Female	Reference	Reference
Male	0.97 (0.63 to 1.49), 0.90	0.66 (0.37 to 1.12), 0.12
Marital Status		
Not married	Reference	Reference
Married	0.65 (0.37 to 1.15), 0.14	0.52 (2.72 to 0.97), 0.04*
Socioeconomic status		
Lower	Reference	Reference
Middle	1.18 (0.65 to 2.13), 0.59	0.94 (0.44 to 2.03), 0.88
Higher	1.55 (0.77 to 3.15), 0.22	1.20 (0.50 to 2.90), 0.69

Abbreviations: OR= 95% CI = Confidence Interval; [1]Reference group is non-exercisers. *$p<0.05$; **$p<0.01$;

Discussion

The present study evaluated PA levels among Nigerian adults and its associations with sedentary behaviour, HRQoL, loneliness, and sleep quality during the COVID-19 lockdown. We further examined whether socio-demographic characteristics predicted exercise behaviour before and during the lockdown period in Nigeria. Our findings showed that 33.1% of the sample did not meet the recommended guideline for sufficient moderate-to-vigorous PA, and females were

unlikely to meet this guideline. Further, exercise behaviour before and during the lockdown period was influenced differently by age and marital status.

This is one of the few studies that examined the impact of COVID-19 lockdown on PA levels among adults Nigerians. The percentage of those who did not attain MVPA levels during the lockdown was high. The lockdown had a serious impact on the PA levels of Nigerian adults. Experts and researchers advocated for the need to be physically active during the lockdown, particularly for those with underlying comorbidities or suppressed immune systems, to combat the devastating effect of exposure to the coronavirus (Chen *et al.*, 2020; Hammami *et al.*, 2020). Likewise, deliberate efforts were made at the inception of the lockdown to encourage the populace to engage in physical activity. However, there have been previous reports of barriers to PA engagement (i.e., poor aesthetics, street connectivity, poor hygienic qualities of neighbourhood, traffic volume, high crime rate) in this clime (Oyeyemi *et al.*, 2019). Despite the calls to increase participation in PA, these barriers might have prevented people from exercising during the lockdown period.

The level of physical inactivity (33.1%) in this present study was similar to those reported in previous studies conducted in Nigeria before the emergence of the novel coronavirus [(Oyeyemi *et al.*, 2013) (31.4%); (Oyeyemi *et al.*, 2018) (22%)]. However, the result of our study contrasts with those of recent studies on the impact of the COVID-19 lockdown on PA (Lesser & Nienhuis, 2020; Sañudo *et al.*, 2020; Tison *et al.*, 2020; Zaccagni *et al.*, 2021). For example, Sañudo *et al.* (2020) explored PA levels, sedentary behaviour, and sleep patterns before and during Spain's lockdown and showed a significantly different lower moderate-vigorous PA, walking and step counts during COVID-19 lockdown. Similarly, in a study of adult Canadians, Lesser and Nienhuis (2020) showed that 63.4% reported being inactive, while only 36.6% were physically active during the lockdown. The COVID-19 lockdown significantly led to a decline in PA levels and participation among Canadians; however, such was not replicated in the present study sample. Likewise, global data on step counts from a smartphone app showed 5.5% decrease ten days after the coronavirus disease was accorded its pandemic status and further decreased by 27.3% within 30 days (Tison *et al.*, 2020).

One explanation for these modest levels of PA in our study could be the low-level of compliance with the COVID-19 lockdown restrictions. As the countries of these comparative studies ideally have marked higher levels of PA due to their exercise culture and the built environment (Salvo *et al.*, 2018), it may therefore be easy to observe significant drops in PA levels during the lockdown period. However, in a generally low-exercising context like Nigeria, there may be little or no significant changes in the PA levels of residents. In addition, the lower percentage of respondents who were physically inactive during the lockdown in the present

study may be attributed to the anecdotal observation of people working in the informal sector defying the lockdown restrictions to earn a living during this period, as there was no support for such individuals from the government. Tison *et al.* (2020) reported that countries like Sweden did not declare national lockdown during the pandemic and showed a minimal decrease in the step count report. Also, our participants were relatively young; although the comparison in the achievement of MVPA between age groups was not significant, younger participants reported meeting the recommended MVPA levels.

In addition, only the physical component subscale of the HRQoL showed a positive association with PA during COVID-19 lockdown after controlling for socio-demographic variables for all study samples and the female subgroup. This finding suggests a potential positive link between PA and physical components of HRQoL. Substantial evidence is available on the association between PA and QoL among healthy adults (Cohen *et al.*, 2016; Ge *et al.*, 2019). Based on the present study's findings, results on other variables such as loneliness and sleep quality were in the expected directions with total PA; however, such associations did not reach a statistically significant level. The COVID-19 lockdown was expected to negatively impact mental health, social interaction, and general well-being (Marconcin *et al.*, 2022). Lesser and Nienhuis (2020) found that PA was strongly associated with well-being; those who engaged in more PA during the COVID-19 restriction had lower anxiety than those who engaged in less activity.

The findings from our study that the exercise behaviour of adult Nigerians before and during the COVID-19 lockdown did not differ significantly is contrary to those of Lesser and Nienhuis (2020), which showed a significant change in PA behaviour reported during the COVID-19 lockdown. In Lesser and Nienhuis' study, 40.5% of those categorised as "inactive" based on 150 minutes of moderate-to-vigorous PA reported that their PA was less during COVID-19 lockdown (Lesser & Nienhuis, 2020). However, there are a few differences between the present study and that of Lesser & Nienhuis. Firstly, the two studies were conducted in two countries with different physical exercise cultures (Nigeria vs. Canada). Secondly, while we asked questions about exercise behaviour retrospectively and during the COVID-19 lockdown, Lesser and Nienhuis assessed changes (whether it was the same, increased or decreased) in the current PA behaviour of respondents.

However, we found that pre-COVID-19 and during the lockdown, younger and unmarried participants were more likely to be non-regular exercisers. In contrast, older and unmarried participants are more likely to be regular exercisers. Overall, age and marital status were strong predictors of exercise behaviour in this study. One of the possible reasons for older participants being regular exercisers relative to younger adults, particularly during the COVID-19 lockdown, is that younger

participants were more likely to engage in sedentary pursuits, including watching TV, using mobile phones and playing computer video games.

A major strength of this study was that data collection occurred immediately following the COVID-19 lockdown imposed by the Nigerian government, which allowed a capture of the immediate and precise impact of the lockdown on PA levels. Also, the subjective measurement tools used in this study are valid and reliable. However, some of the limitations of this study included non-availability of PA, loneliness, sleep quality, quality of life and exercise behaviour data before COVID-19 lockdown, from which comparison could have been drawn. Similarly, the self-report measures of PA used in this study could have resulted in over-reporting or under-reporting, which may have led to attenuation in the association between PA and health-related outcomes (Celis-Morales *et al.*, 2012). Despite this constraint, self-reported PA was the only feasible method the researchers could use during the unprecedented COVID-19 lockdown period. Lastly, this study used WhatsApp to invite the participants through a web link; this recruitment process could have introduced selection bias. Also, the researchers could not ascertain that the respondents were only from within the selected states. Thus, it is difficult to clearly define the study sample and response rates because the number of individuals who viewed the survey link viz a viz how many responded were unknown. This limits the generalisation of the present findings.

Conclusions and Health Policy Implications

In conclusion, the COVID-19 lockdown had some degree of negative impact on the PA levels among adults in Nigeria. Females were more unlikely to meet the recommended PA guidelines. Higher physical health-related quality of life predicted higher total PA levels. There was no difference in the subjective report of exercise behaviour before and during the lockdown. However, age categories and marital status influenced exercise behaviour differently before and during the COVID-19 lockdown period. There is a need for further exploration of the long-term effects of COVID-19 lockdowns on Nigerian adults' PA levels and exercise behaviour. The findings imply that public health professionals continue to advocate the need for the Nigerian population to be physically active during this unprecedented situation and future pandemics.

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Declaration of conflicting interests
The authors declare no conflicts of interest.

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Supplementary Material

Geographical locations of Respondents

Geopolitical zone	State	Frequency	Percentage
South-South	Edo	89	17.5
	Delta	48	9.5
South-East	Enugu	47	9.3
	Anambra	30	5.9
South-West	Lagos	68	13.4
	Osun	44	8.7
North-Central	Abuja	35	6.9
	Kwara	30	5.9
North-East	Taraba	18	3.6
	Bauchi	20	3.9
North-West	Kano	32	6.3
	Kaduna	46	9.1
Total	12	507	100