Journal of Contemporary Studies in Epidemiology and Public Health
2023, 4(1), ep23001
e-ISSN: 2634-8543
https://www.jconseph.com

MODESTUM

Original Article

OPEN ACCESS

Influence of neighborhood environment and social support on physical activity among patients with diabetes mellitus

Adekola B Ademoyegun [1,2*], Chidozie E Mbada [3], Olubukola E Afolabi [1], Ishanosen A Aghedo [1], Omotola I Adelowokan [1], Taofeek O Awotidebe [2]

[1] Department of Physiotherapy, Osun State University Teaching Hospital, Osogbo, NIGERIA
[2] Department of Medical Rehabilitation, College of Health Sciences, Obafemi Awolowo University, Ile-Ife, NIGERIA
[3] Department of Health Professions, Faculty of Health and Education, Manchester Metropolitan University, Birley Fields Campus, Bonsall Street, Manchester M15 6GX, UK
***Corresponding Author:** aademoyegun@gmail.com

Citation: Ademoyegun AB, Mbada CE, Afolabi OE, Aghedo IA, Adelowokan OI, Awotidebe TO. Influence of neighborhood environment and social support on physical activity among patients with diabetes mellitus. J CONTEMP STUD EPIDEMIOL PUBLIC HEALTH. 2023;4(1):ep23001. https://doi.org/10.29333/jconseph/12549

ARTICLE INFO

Received: 20 May 2022
Accepted: 09 Oct. 2022

ABSTRACT

This study was aimed to determine the relationship of physical activity (PA) with the neighborhood environment and social support for PA among patients with diabetes mellitus (DM). A total of 193 consenting individuals with DM attending endocrinology clinic in a Nigerian tertiary hospital participated in this cross-sectional study. The international physical activity questionnaire short form, physical activity neighborhood environment scale (PANES), and physical activity and social support scale (PASSS) were used to assess the PA level (low, moderate, and high), neighborhood environment and social support for PA, respectively. The results of bivariate analyses showed that all elements of built environment and social support were significantly associated with PA. Regression model analyses indicate that PANES score was associated with moderate (adjusted odds ratio [aOR]: 10.76; 95% confidence interval [CI]: 3.82-30.32) to high (aOR: 45.73; 95% CI: 12.14-172.27) PA. In addition, easy access to quality walking facilities (aOR: 46.53; 95% CI: 3.89-557.32; aOR: 46.13; 95% CI: 2.65-802.40) and easy access to recreation infrastructure (aOR: 46.89; 95% CI: 3.95-487.83; aOR: 17.99; 95% CI: 1.28-252.98) were associated with moderate to high PA, respectively, while safety from crime (aOR: 0.21; 95% CI: 0.07-0.64) and easy access to services and shops (aOR: 21.90; 95% CI: 1.83-262.59) were associated with moderate and high PA. Informational social support was associated with moderate PA (aOR: 1.44; 95% CI: 1.04-2.00). In conclusion, the neighborhood environmental and social support factors were associated with the PA activity level among Nigerian patients with DM.

Keywords: physical activity, built environment, social support, public health, diabetes mellitus

INTRODUCTION

Diabetes mellitus (DM) is a chronic, metabolic disease characterized by elevated blood glucose levels which results, over time, to severe damage to the blood vessels, nerves, and to the major organs of the body [1]. Recent reports have shown that about 171 million people are affected by DM worldwide and its prevalence is estimated to be doubled by 2030 [2]. Furthermore, epidemiological data have shown that the prevalence of DM has increased proportionately [3]. Specifically, a prevalence of up to 10% is reported in Nigeria [4] of which approximately two million of the cases of DM are unfortunately undiagnosed, and the yearly deaths related to DM in Nigeria were assessed to be 105,091 cases [5].

The management of DM include medications, diet and behavioral or lifestyle changes. One of the lifestyle factors in the management of DM involves engaging in physical activity (PA) [6]. PA is defined as a behavior, particularly a body movement, that occurs from the contraction of skeletal muscle and which results in increased energy expenditure which is more than the resting metabolic rate [7]. According to the recommendations of the American Diabetes Association, patients with diabetes should do a minimum of 150 minutes of moderate-intensity aerobic PA and a minimum of 60 minutes of vigorous-intensity PA weekly [8].

A study reported that moderate to high intensities aerobic PA and increased levels of cardio-respiratory fitness are associated with significant reductions in the morbidity and mortality in both males and females with type 1 and type 2 diabetes [9]. Participation in PA assist patients with diabetes to achieve decreased insulin resistance, increased cardio-respiratory fitness, improved glycemic control, increased vigor, improved lipid profile, maintenance of weight loss and blood pressure reduction [10-12]. However, despite the incontrovertible evidence of PA as being a positive contributor to general health and wellbeing, physical inactivity is a common phenomenon worldwide among different populations including those with diabetes [13, 14].

In Nigeria, recent report had indicated that patients with DM have low level of PA participation [15] indicating the need to further assess the factors influencing participation and

engagement in PA among patients with DM in the Nigeria context.

Drawing from the socio-ecological model, as used in health intervention protocols, it has been proven that health behavior is influenced by different but multiple levels of individual, social, cultural, physical environment, and policy [16]. Consequent to the foregoing, the main socio-ecological factors implicated in literature as influencing PA levels are environmental and social factors. Neighborhood environmental factors have been shown to be associated with different levels of PA [17-19]. Neighborhood environment includes the social and the physical environments [20]. Physical environment measures the objective aspect of the neighborhood environment and it include the neighborhood design while the social environment is characterized by using the administrative data which describes the availability of services that promote social interaction and organization [21].

Findings from the study by Chiang et al. [22] highlighted the advantages of an activity-friendly neighborhood environment in the engagement in PA. In some developed nations, studies have also shown that individuals that live in supportive built physical neighborhood environment (high residential density, well-connected streets, a mixture of land uses, and pedestrian facilities that support active transportation) had higher participation in PA than those living in areas without supportive environment [23-25]. However, the results of these studies have been reported to have little or no applicability to Africa due to different environmental neighborhood [26, 27]. Besides, most of these studies were carried out among apparently healthy individuals indicating the need for studies investigating the relationship between PA participation and local neighborhood environment especially as it relates to Nigerian patients with DM.

One of the encouraging factors that enable individuals including people with DM to participate in PA is social support [28-30], and it has been shown through systematic reviews that support from family and friends for an individual enhances PA behavior [31-35]. Social support is a social determinant of health defined as the degree to which a person's basic social needs (which includes belonging, security, identity, affection and esteem or approval) are satisfied by interaction with others [36]. Social support has been reported to be a key contributor to participation in PA through the buffering hypothesis [30]. The hypothesis provides that social support reduces the unpleasant experiences of undergoing stressful event like PA through the development of better coping mechanisms, and by altering or lowering the affective, physiological, or abnormal response of the individuals to a stressful event [30, 37] including that of the PA. Although, several studies have characterized the relationship between social support and PA, the results of these studies did not evaluate all aspects of functional social support [30].

The five well-validated aspects of functional social support are emotional, companionship, instrumental, informational, and validation [37, 38], however, most studies on PA and social support mainly focused on three (companionship, emotional, and instrumental) of the five forms of functional social support [30, 32, 34]. The lack of information on the relationship of PA with all aspects of social support has been attributed to lack of validated instrument that assesses all forms of social support until recently when a new validated instrument was developed that could assess all the domains of functional social support [30]. Moreover, omission of some aspects of social support as it relates to PA may hamper understanding the true relationship between PA and all aspects of social support and may also undermine processes undertaking in providing targeted or individualist social support intervention for PA [30]. Besides, socio-demographic and socio-cultural characteristics influence how individuals perceive the type and level of social support they receive [29].

Thus, there is need to investigate the influence of social support on PA in the Africa setting especially in Nigeria. As stated earlier, socio-ecological model provides that multiple interactions and undercurrent are responsible for health behavior, however, to our knowledge, there is no study conducted to investigate interplay of environmental and social factors on PA participations in disease population especially among patients with DM. This study was aimed to evaluate the influence of neighborhood environment and social support on PA levels among patients with DM in Nigeria. Understanding the environmental and social correlates of PA among Nigerians with DM is useful for policies and programmatic actions to enhancing PA in this population, as well as others.

MATERIALS AND METHODS

Setting and Respondents

This cross-sectional study was conducted between March and December 2021. The respondents were patients with DM attending the Endocrinology Clinic of the Osun State University Teaching Hospital, Osogbo, Nigeria. Patients with type 1 or 2 DM who were 18 years and older were included in the study. However, those with other underlying medical conditions apart from diabetes that may impair PA e.g., stroke; musculoskeletal problems or deformity preventing them from engaging in PA e.g., amputation; aphasia, major hearing problem, and those with impaired cognitive function were excluded from the study. The sample size was calculated using the formula for cross-sectional survey: $N=Z^2p(1-p)/e^2$ [39], where N is the required sample size, Z is standard normal deviation (95% confidence level=1.96), p is pre- study estimate of proportion, and when considered the prevalence (p) of DM in Nigeria, which has been estimated to be 10% [4], p=10, while e is the desired level of precision (0.05), and $N=1.96^2\times10(1-10)/0.05^2=125$. Therefore, a minimum of 125 respondents were required for this study. However, a total of 193 respondents were recruited. Verbal confirmation and marking of the charts of interviewed patients were used to avoid data recycling.

Instrument and Measurement

Socio-demographic characteristics

A self-developed proforma was used to collect data on physical, clinical, and socio-demographic characteristics (age, sex, BMI, time since diagnosis of diabetes, employment, marital, education status, and income level) of the eligible respondents. Marital status was classified as married or single. Education was classified as no formal, primary, secondary, and tertiary education levels. Employment status was categorized into employed and unemployed. Income was categorized into three groups of low (<$2 per day), medium ($2-$5 per day) and high (>$5 per day) income levels. The body mass index was categorized into normal weight (<25 kg/m^2) and overweight/obese (≥25 kg/m^2). None of the respondents was underweight. Waist circumference (assessed at the midpoint

between the iliac crest and the lower costal margin) was measured with a non-stretch tape to the nearest centimeters. Waist circumference values ≤102 cm and ≤88 cm were classified as normal in male and female respondents [40].

Physical activity assessment

The self-reported PA of the respondents was evaluated by the International PA questionnaire short form (IPAQ-SF). The IPAQ-SF is an instrument comprising seven items eliciting information on PA performed for at least 10 minutes at a time over the last seven-day period. The questionnaire collects information on the number of days and average time per day spent on PA in terms of vigorous-intensity activity, moderate-intensity activity, and walking activity. The metabolic equivalent task (MET) scores, which is the individual's working metabolic rate relative to resting metabolic rate [6], was calculated for each of the three domains in order to assess the intensity of PA of the respondents. The MET score was derived by multiplying the total minutes and days of PA within a week with the MET for each of vigorous PA (MET=8.0), moderate PA (MET=4.0), and walking (MET=3.3). The total MET was obtained by adding all the MET values of the three domains in IPAQ-SF together. The total MET was categorized into low (<600 MET-min per week), moderate (≥600 MET-min per week) and high (≥3,000 MET-min per week) PA levels. Furthermore, respondents were categorized into health-enhancing PA (HEPA) and non-health-enhancing PA groups based on the PA global recommendations [22, 41-43]. In order to eliminate or reduce the reported problem of overestimation of PA by the use of questionnaire, the second item (question on moderate PA) on IPAQ-SF was reordered as item 1 and vice-versa in this study. Evidence has shown that the placement of vigorous–before moderate–intensity items on IPAQ contribute to overestimation of PA due to possible double-counting of activity [44-46]. The IPAQ- SF has been reported to have a consistent high criterion validity and reliability (0.66 to 0.88) in assessing PA [47, 48].

Neighborhood environment assessment

The physical activity neighborhood environment scale (PANES) was used to assess the perceived physical neighborhood environment of the respondents. The PANES items assess neighborhood attributes in terms of social environment, aesthetics, and walkability. The PANES is a 17-item survey (seven core and 10 optional) which assesses the perceived neighborhood environment in relation with PA. The seven core items, used in this study, evaluate residential density; access to shops/ services, public transit, and recreation facilities; presence of sidewalks, bike paths; and personal safety from crime. The core items, apart from the residential housing item, were asked by applying a 4-point Likert scale ranging from "strongly disagree" to "strongly agree" while the housing item was asked by using a 5-point scale. Neighborhood has previously been defined as the area within a 10 to 15 minute walk from home [49]. PANES was scored by summing the dichotomized items 1 through 6 and created a summary score that ranges from zero to six based on the Likert-scale response options [50]. The higher the PANES score the greater the neighborhood environmental support for PA. Dichotomized PANES items have been reported to have acceptable validity and reliability [49]. Furthermore, response options of items 2 to 7 were collapsed and recoded into a 2-level variable 'no' (strongly disagree and somewhat disagree options) vs. 'yes' (strongly agree and somewhat agree options) in response to their perceived neighborhood environment in relation to PA. The PANES is reported to place less survey burden on the respondents with adequate content validity and test-retest reliability (0.52 to 0.88) in assessing relationship between physical neighborhood and PA outcomes [50-52].

Social support assessment

The physical activity and social support scale (PASSS) was used to assess the respondents' level of perceived social support for PA. The PASSS has 20 items eliciting information on the level of social support received to participate in PA. The degree of social support was assessed by using a Likert-type scale with scores ranges from 1 (never), 4 (sometimes), 7 (always) to 0 (not applicable). This scale analyzes five forms of social support which include companionship, instrumental, emotional, validation and informational [30]. The maximum total PASSS score is 140. The higher the PASSS score the higher the degree of social support experienced by the respondents to engage in PA [30]. Furthermore, the five aspects of PASSS were scored separately by adding the scores equivalent to the response on the items for each aspect of social support. The corresponding items for the five forms of social support on PASSS are: emotional support (items 1-4), validation support (items 5-8), informational support (items 9-12), companionship support (items 13-16), and instrumental support (items 17-20). The maximum score for each of the aspect of social support on PASSS is 28. The validity of PASSS in assessing social support for PA has been reported as adequate with test-retest reliability of 0.82 [30]. Since Yoruba is the common language in the study setting, the IPAQ-SF, PANES, and PASSS were culturally translated and adapted to Yoruba language. Ethical clearance was obtained from Research Ethics Committee of the Osun State University Teaching Hospital Osogbo, Nigeria. The purpose of the research was explained to the respondents and their written informed consent was obtained before the commencement of the study.

Data Analysis

Descriptive statistics of frequency, percentage, mean, and standard deviation was used to summarize data. Chi-square was used to evaluate the association of socio-demographic, physical and neighborhood environmental factors with PA levels, while Spearman' rank-order coefficients was employed to assess the correlations of elements of perceived social support and neighborhood environment with the total amount and types (vigorous, moderate, and walking) of PA. The relationship between PA levels (low, moderate, and high) and social support and neighborhood environmental factors was examined by multinomial logistic regression expressed in odds ratio (OR) and 95% confidence interval (CI). While using respondents in low level PA as reference group, the social support and neighborhood environment variables were entered in model 1. Model 2 was however adjusted for age, gender, marital status, educational level, income, and employment status. Alpha level was set at $p<0.05$. Data analyses were carried out using SPSS 21.0 version software (SPSS Inc., Chicago, IL, USA).

RESULTS

The mean age of the respondents was 58.5±11.5 years, higher proportion of the respondents were women (63.7%), those with tertiary education (39.9%), and those who had high

Table 1. Association between socio-demographic characteristics and physical activity levels of the respondents (N=193)

Variable	Total n (%)	Physical activity levels			χ^2	p-value
		Low level n (%)	Moderate level n (%)	High level n (%)		
Gender					2.217	0.330
Male	70 (36.3)	44 (40.7)	14 (29.2)	12 (32.4)		
Female	123 (63.7)	64 (59.3)	34 (70.8)	25 (67.6)		
Age					8.032	0.018*
≤64	134 (69.4)	66 (61.1)	38 (79.2)	30 (81.1)		
≥65	59 (30.6)	42 (38.9)	10 (20.8)	7 (18.9)		
Education					22.588	0.001*
None	18 (9.3)	13 (12.0)	4 (8.3)	1 (2.7)		
Primary	34 (17.6)	23 (21.3)	4 (8.3)	7 (18.9)		
Secondary	64 (33.2)	43 (39.8)	9 (18.8)	12 (32.5)		
Tertiary	77 (39.9)	29 (26.9)	31 (64.6)	17 (45.9)		
Marital status					1.384	0.501
Married	158 (81.9)	91 (84.3)	39 (81.3)	28 (75.7)		
Single[a]	35 (18.1)	17 (15.7)	9 (18.7)	9 (24.3)		
Income level					6.875	0.143
Low	77 (39.9)	49 (45.4)	15 (31.3)	13 (35.1)		
Medium	69 (35.8)	31 (28.7)	20 (41.7)	18 (48.6)		
High	47 (24.4)	28 (25.9)	13 (27.1)	6 (16.2)		
Employment					16.052	0.003*
Formal	30 (15.5)	11 (10.2)	14 (29.2)	5 (13.5)		
Self-employed	102 (52.8)	68 (63.0)	15 (31.3)	19 (51.4)		
Unemployed	61 (31.6)	29 (26.8)	19 (39.5)	13 (35.1)		
BMI					4.328	0.115
Normal	75 (38.9)	42 (38.9)	14 (29.2)	19 (51.4)		
Overweight/obesity	118 (61.1)	66 (61.1)	34 (70.8)	18 (48.6)		
Waist circumference					9.046	0.011*
Normal	50 (25.9)	27 (25.0)	7 (14.6)	16 (43.2)		
High	143 (74.1)	81 (75.0)	41 (85.4)	21 (56.8)		

Note. [a]Including the unmarried, separated, and widowed; χ^2: Results of the Chi-square test of association between socio-demographic characteristics and the physical activity levels; *Indicates significant association at p< 0.05; & BMI: Body mass index

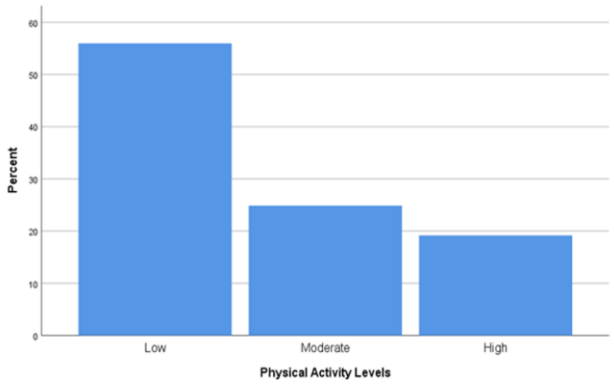

Figure 1. Bar chart showing the proportion of physical activity levels of the respondents (Source: Authors own elaboration)

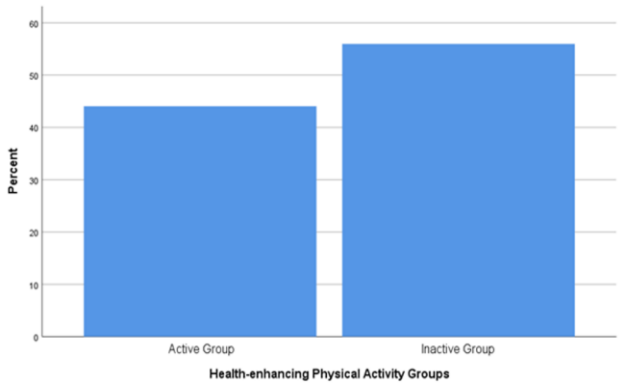

Figure 2. The distribution of the health-enhancing physical activity participation by the respondents (Source: Authors own elaboration)

waist circumference (74.1%). The rates for low, moderate, and high levels of PA were 56.0%, 24.9%, and 19.1%, respectively, 44% and 56% of the respondents engaged in health-enhancing and non health-enhancing PA. The mean and standard deviation of the total PASSS and PANES scores were 56.87±38.61 and 2.17±2.04 (**Table 1**, **Figure 1**, and **Figure 2**). Those considered as active in the health-enhancing physical activity (HEPA) were respondents who met at least 600 MET-min-per week of physical activity.

The PA level was significantly associated with each of age (χ^2=8.032; p=0.018), education status (χ^2=22.588; p=0.001), employment status (χ^2=16.052; p=0.003) and waist circumference (χ^2=9.046; p=0.011) of the respondents (**Table1**).

Furthermore, there was significant association between PA level and most neighborhood environmental factors–easy access to services and shops (χ^2=36.603; p<0.001), easy access to traffic stops (χ^2=42.850; p<0.001), presence of walking facilities (χ^2=47.123; p<0.001), quality of walking facilities (χ^2=45.068; p<0.001), and easy access to recreation infrastructure (χ^2=42.702; p<0.001) (**Table 2**).

The total METs, including vigorous, moderate, and walking PA METs of the respondents was significantly correlated with environmental factor (r=0.76; p<0.001) and perceived social support for PA (r=0.38; p<0.001). The total PA score was also negatively correlated with age (r=-0.2; p<0.001). Meanwhile, total METs was significantly correlated with each of emotional (r=0.30; p<0.001), validation (r=0.32; p<0.001), informational (r=0.38; p<0.001), companionship (r=0.25; p<0.001), and instrumental (r=0.36; p<0.001) aspect of social support. Furthermore, each of vigorous, moderate, and walking type of

Table 2. Associations of neighborhood environmental factors with physical activity levels of the respondents (N=193)

Variable	Physical activity levels			χ^2	p-value
	Low level n (%)	Moderate level n (%)	High level n (%)		
Many shops, stores, markets, or other places to buy things I need are within easy walking distance of my home					
Yes	47 (43.5)	40 (83.3)	33 (89.2)	36.603	0.000*
No	61 (56.5)	8 (16.7)	4 (10.8)		
It is within a 10-15-minute walk to a transit stop (such as bus, train, trolley, or tram) from my home					
Yes	35 (32.4)	25 (52.1)	35 (94.6)	42.850	0.000*
No	73 (67.6)	23 (47.9)	2 (5.4)		
There are sidewalks on most of the streets in my neighborhood					
Yes	14 (13.0)	29 (60.4)	22 (59.5)	47.123	0.000*
No	94 (87.0)	19 (39.6)	15 (40.5)		
There are facilities to bicycle in or near my neighborhood like special lanes, separate paths, or trails, shared use paths for cycles and pedestrians					
Yes	13 (12.0)	11 (22.9)	25 (67.6)	45.068	0.000*
No	95 (88.0)	37 (77.1)	12 (32.4)		
My neighborhood has free/low cost recreation facilities (parks, walking trails, bike paths, recreation centers, playgrounds, public swimming pools)					
Yes	14 (13.0)	8 (16.7)	24 (64.9)	42.702	0.000*
No	94 (87.0)	40 (83.3)	13 (35.1)		
The crime rate in my neighborhood makes it unsafe to go on walks at night					
Yes	57 (52.8)	23 (47.9)	18 (48.6)	0.379	0.820
No	51 (47.2)	25 (52.1)	19 (51.4)		

Note. χ^2: Chi-square test of association & *Indicates significant association at p<0.001

Table 3. Correlations of physical activity with neighborhood environment and social support factors

	1	2	3	4	5	6	7	8	9	10	11	12	13
Total PA (MET)	–												
Vigorous PA (MET)	0.68**	–											
Moderate PA (MET)	0.71**	0.73**	–										
Walking PA (MET)	0.81**	0.32**	0.29**	–									
PANES score	0.76**	0.62**	0.67**	0.51**	–								
PASSS total score	0.38**	0.40**	0.31**	0.21**	0.53**	–							
PASSS-EMO	0.30**	0.35**	0.25**	0.29**	0.51**	0.87**	–						
PASSS-VAL	0.32**	0.35**	0.25**	0.16*	0.48**	0.84**	0.66**	–					
PASSS-INF	0.38**	0.38**	0.29**	0.24**	0.51**	0.88**	0.68**	0.78**	–				
PASSS-COM	0.25**	0.22**	0.18**	0.16**	0.45**	0.82**	0.63**	0.63**	0.78**	–			
PASSS-INS	0.36**	0.39**	0.29**	0.19**	0.38**	0.82**	0.69**	0.69**	0.61**	0.55**	–		
Duration	0.12	0.07	-0.03	0.13	0.06	0.14	0.12	0.14	0.13	0.18*	0.11	–	
Income	-0.003	0.040	0.100	-0.090	0.005	0.090	0.040	0.130	0.170**	0.090	-0.040	-0.090	–
Age	-0.20**	-0.16*	-0.20**	-0.110	-0.16*	-0.070	-0.008	-0.120	-0.060	-0.060	-0.040	0.31**	0.130

Note. PA: Physical activity; MET: Metabolic equivalent of task; PANES: Physical activity neighborhood environment scale; PASSS: Physical activity and social support scale; PASSS-EMO: Physical activity and social support scale-emotional support; PASSS-VAL: Physical activity and social support scale-validation support; PASSS-INF: Physical activity and social support scale-informational support; PASSS-COM: Physical activity and social support scale-companionship support; PASSS-INS: Physical activity and social support scale-instrumental support; *Indicates significant correlation at p<0.05; & **Indicates significant correlation at p<0.001

PA was significantly correlated with the environmental and social support factors (p<0.05) (**Table 3**).

In the first model of multinomial logistic regression analyses, the neighborhood environment (PANES score) was significantly associated with moderate (OR: 6.77; 95% CI: 3.01-15.24) and high (OR: 32.60; CI: 10.31-103.07) levels PA compared with respondents with low PA level. In this model, respondents were likely to engage in moderate PA with presence of easy access to traffic stops (OR: 3.69; 95% CI: 1.11-12.26), quality walking facilities (OR: 40.46; 95% CI: 4.64-352.28), easy access to recreation infrastructure (OR: 7.89; 95% CI: 1.22-51.34), and safety from crime (OR: 0.36; 95% CI: 0.14-0.94). In addition, respondents with quality walking facilities were likely to engage more in high PA (OR: 47.69; 95% CI: 3.71-612.43). Respondents with information social support were likely to engage in high PA (OR: 1.36; 95% CI: 1.04-1.79).

After adjusting for age, gender, marital status, educational level, income, and employment status in model 2, respondents living in areas with better neighborhood environmental support for physical activity (PANES score) engaged more not only in moderate PA (OR: 10.76; 95% CI: 3.82-30.32) but were also highly physically active (OR: 45.73; 95% CI: 12.14-172.27). In addition, respondents with easy access to quality walking facilities (OR: 46.53; 95% CI: 3.89-557.32; OR: 46.13; 95% CI: 2.65-802.40) and easy access to recreation infrastructure (OR: 46.89; 95% CI: 3.95-487.83; OR: 17.99; 95% CI: 1.28-252.98) were moderately to highly physically active, while those with neighborhood perceived to be safe from crime (OR: 0.21; 95% CI: 0.07-0.64) and with easy access to services and shops (OR: 21.90; 95% CI: 1.83-262.59) were more moderately or highly physically active, respectively. Respondents with high PA had more informational social support (OR: 1.44; 95% CI: 1.04-2.00) than those with low PA (**Table 4**).

DISCUSSION

The findings of this study show that majority (56%) of the patients with DM assessed did not engage in health-enhancing PA and therefore were physically inactive indicating that the

Table 4. Multinomial logistic regression analysis showing relationship of PA with environmental and social support factors

	Model 1[a]		Model 2[b]	
	M PA OR (95% CI)	**High PA OR (95% CI)**	**M PA OR (95% CI)**	**High PA OR (95% CI)**
Social support factors				
PASSS score	0.99 (0.79-1.24)	0.89 (0.69-1.14)	1.11 (0.84-1.46)	0.83 (0.61-1.12)
Emotional support	0.99 (0.78-1.25)	1.18 (0.89-1.54)	0.89 (0.66-1.19)	1.27 (0.92-1.74)
Validation support	1.05 (0.83-1.33)	1.18 (0.90-1.53)	0.94 (0.71-1.25)	1.19 (0.88-1.62)
Informational support	1.09 (0.86-1.39)	1.36 (1.04-1.79)*	0.91 (0.68-1.19)	1.44 (1.04-2.00)*
Companionship support	0.99 (0.79-1.24)	1.02 (0.79-1.32)	0.90 (0.69-1.19)	1.11 (0.82-1.50)
Instrumental support	1.06 (0.85-1.34)	1.12 (0.87-1.46)	0.96 (0.72-1.27)	1.24 (0.91-1.69)
Nagelkerke's R^2	34.6%		49.7%	
Environmental factors				
PANES score	6.77 (3.01-15.24)**	32.60 (10.31-103.07)**	10.76 (3.82-30.32)**	45.73 (12.14-172.27)**
Easy access to services and shops	0.62 (0.18-2.13)	6.23 (0.84-46.26)	0.99 (0.22-4.49)	21.90 (1.83-262.59)*
Easy access to traffic stops	3.69 (1.11-12.26)*	0.90 (0.10-8.17)	3.94 (0.99-15.69)	0.51 (0.05-5.06)
Presence of walking facilities	0.27 (0.05-1.56)	1.94 (0.22-17.42)	0.34 (0.04-2.72)	3.55 (0.27-46.33)
Quality of walking facilities	40.46 (4.64-352.28)*	47.69 (3.71-612.43)*	46.53 (3.89-557.32)*	46.13 (2.65-802.40)*
Easy access to recreation infrastructure	7.89 (1.22-51.34)*	3.17 (0.42-24.15)	46.89 (3.95-487.83)*	17.99 (1.28-252.98)*
Safety from crime	0.36 (0.14-0.94)*	0.34 (0.08-1.44)	0.21 (0.07-0.64)*	0.35 (0.07-1.86)
Nagelkerke's R^2	78.9%		83.4%	

Note. The reference group are respondents in low level physical activity group; [a]Model 1 is the unadjusted model; [b]Model 2 was adjusted for age, gender, marital status, educational level, income, & employment status; M: Moderate; OR: Odd ratio; CI: Confidence interval; PA: Physical activity; PASSS: Physical activity & social support scale; PANES: Physical activity neighborhood environment scale; *Indicates significance at p<0.05; & **Indicates significance at p<0.001

MET of their total PA was below minimum recommendation of 600 MET-min per week. This finding is similar to PA level obtained among diabetes patients in other climes including Nigeria [15, 53], Batswana [54], Ghana [55], and Nepal [6]. However, higher level of PA participation was reported among patients with DM in the North Carolina, USA wherein 56% were said to have engaged in moderate or high PA weekly [56].

Even though PA participation is generally low among Nigerian adult population, a recent comparative study reported a lower PA level among Nigerian patients with DM compared to healthy control [15]. The authors, however, observed that both groups in the study had low level of PA and therefore opined that factors other than health status of the patients were responsible for their physical inactivity [15]. Reports have earlier shown that patients with DM abstain from engaging in PA for fear of triggering hypoglycemic crisis [57]. Therefore, public awareness, targeted education, and individualized interventions on the health benefits of PA on mortality and morbidity of DM should be undertaken by the governments, policy makers and clinicians.

Furthermore, the results of this study show that friendly PA neighborhood environment, indicated by high PANES scores is associated with high participation in PA. In other words, patients who reside in environment perceived to be supportive in PA participation engaged in moderate or high PA. Moreover, the neighborhood environmental support for PA was strongly and positively correlated with each type of PA (vigorous, moderate, and walking) assessed in this study suggesting that a supportive environment is needed for optimum participation in any type of PA. Previous studies have reported positive association between built environment and PA among healthy populations generally [17, 18]. Our study further analyzed the relationship of each built environment with PA in this population. In this respect, easy access to services and shops, easy access to traffic stops, presence of walking facilities, quality of walking facilities, and easy access to recreation infrastructure were associated with PA in the bivariate analysis.

However, in the multivariate analysis, easy access to quality walking facilities, safety from crime and easy access to recreation infrastructure were related to patients with DM engaging in moderate to high levels of PA. It was reported that patients with diabetes considered distance to exercise facilities as a main barrier to regular participation in PA and exercise [15]. Furthermore, external factors including lack of safe road and place to exercise were similarly reported as barriers to PA participation by Indian diabetes patients [58]. The World Confederation for Physical Therapy had previously suggested for the inclusion of environmental, community and policy factors in designing PA programs [59], and since attributes of physical environmental factors could influence PA participation by diabetes patients, environment favorable to PA participation should be considered by Nigerian policymakers in developing or improving health-related programs including PA program.

In this study, the PA of the patients was positively correlated with the perceived social support. The results further showed that each of the type of PA (vigorous, moderate, and walking) participated in by the patients was associated with the perceived social support and its elements. This indicates that patients with higher perceived social support from family, friends, community etc. engaged more in PA. Studies have reported that social support is a predictor for PA participation [28-35] including those living with diabetes [6, 15, 58, 60-62]. A strength of this study is the use of instrument that assesses all elements of social support in PA as previous studies on relationship between social support and PA did not take into consideration the influence of different forms of social support on patterns of PA.

In this study, the PA was positively correlated with each of the emotional, validation, informational, companionship, and instrumental elements of social support. It can therefore be inferred that every element of social support is important in enhancing PA participation and therefore should be offered to this population. In fact, the informational aspect of social support had the highest correlation with PA in this study and the association was maintained in the regression models showing that the cohort relied heavily on the information or instructions concerning PA to be physically active. Such

information might have included the health-benefits of PA and information on availability of infrastructure for PA.

Informational support has been described as easy accessibility of information or instruction for the behavior or behavior change or means to improve the behavior [30]. This information on health-benefits of PA may be provided for this cohort and similar patient population by the use of materials including leaflets, social media, mass media, pamphlets, posters etc. by governments, civil societies, clinicians, family etc.

With respect to the socio-demographics, age, employment, and education status were associated with PA levels. The younger patients, especially those whose age is below 65 years in this study engaged more in moderate and high levels of PA. Ordinarily, older adults who are generally more susceptible to falls and frailty and may present with more medical co-morbidity and diabetes complications may be reluctant, unwilling, or unable to engage in PA. Special considerations or arrangements may be considered for this population to engage in PA especially those with chronic conditions. A study on prevalence of physical inactivity among Nigerian women reported that older women are more physically inactive than younger women [42]. Additionally, patients with tertiary education and who were employed were more likely to be physically active than those with lower education or unemployed as shown in this study. It was reported that patients with DM with higher education in Nepal were more motivated to engage in PA [6]. It has been suggested that educated and employed individuals generally have more income and have easy access to health information and therefore have better opportunities and resources to engage in PA [22].

This study has some potential limitations. First, we did not evaluate the influence of possible complications of DM, e.g., diabetic peripheral neuropathy on the PA of the respondents. Second, the relationship observed in this study cannot be taken as causality due to the cross-sectional design of the study. Lastly, the PA of the respondents was assessed subjectively by IPAQ-SF. Studies have shown that respondents tended to overestimate their PA levels with this type of measure [63-65] showing possibility of the respondents in this study having lower PA than what was reported. However, the re-ordering of items 1 and 2 of IPAQ-SF may have eliminated or reduced the phenomenon of PA overestimation in this study. Placement of vigorous- before moderate-intensity items on IPAQ has been reported to contribute to overestimation of PA due to possible double-counting of activity [44-46]. A prospective study with the use of objective measure of PA e.g., accelerometer and a larger sample drawn from multiple centers should be considered in the future to consolidate the findings of this study.

CONCLUSION

About 56% of Nigerian patients with DM were physically inactive which was associated with neighborhood environmental and social support factors. These findings may help the urban planners, policymakers, community, carers, family, and clinicians in Nigeria to facilitate policies and programs including provision of social support, social networks, social support-seeking skills, recreational facilities, sports centers, traffic stops, walking facilities and other built environmental facilities that promote PA participation.

Author contributions: ABA: was involved in the design of the study and wrote the initial draft of the manuscript; **ABA, CEM, & TOA:** were involved in data analysis and interpretation; **ABA, CEM, OEA, IAA, OIA, and TOA:** contributed to the written of the final draft of the manuscript; & **OEA, IAA, & OIA:** were involved in data collection. All authors have agreed with the results and conclusions.

Funding: No funding source is reported for this study.

Acknowledgements: The authors would like to thank the patients and staff in the Endocrinology Unit, Department of Internal Medicine, Osun State University Teaching Hospital, Osogbo, Nigeria.

Ethical statement: The authors stated that the ethical clearance was obtained from the Ethical Review Committee of the Osun State University Teaching Hospital, Osogbo, Nigeria and a written informed consent was obtained from each participant.

Declaration of interest: No conflict of interest is declared by authors.

Data sharing statement: Data supporting the findings and conclusions are available upon request from the corresponding author.

REFERENCES

1. Forouhi NG, Wareham NJ. Epidemiology of diabetes. Medicine (Abington). 2014;42(12):698-702. (doi:10.1016/j.mpmed.2014.09.007).
2. Harding JL, Pavkov ME, Magliano DJ, Shaw JE, Gregg EW. Global trends in diabetes complications: A review of current evidence. Diabetologia. 2019;62(1):3-16. (doi:10.1007/s00125-018-4711-2).
3. International Diabetes Federation IDF Diabetes Atlas. International Diabetes Federation IDF Diabetes Atlas, 8th Edition. Brussels, Belgium, 2017. Available at: https://diabetesatlas.org/upload/resources/previous/files/8/IDF_DA_8e-EN-final.pdf
4. Ogbera AO, Ekpebegh C. Diabetes mellitus in Nigeria: The past, present and future. World J Diabetes. 2014;5(6):905-11. (doi:10.4239/wjd.v5.i6.905).
5. Oputa RN, Chinenye S. Diabetes in Nigeria–a translational medicine approach. African J Diab Medicine. 2015;23(1).
6. Kadariya S, Aro AR. Barriers and facilitators to physical activity among urban residents with diabetes in Nepal. PLoS One. 2018;13(6):e0199329. (doi:10.1371/journal.pone.0199329).
7. Centers for Disease Control and Prevention. US Department of Health and Human Services physical activity guidelines for Americans 2008. Washington, DC, 2008. Available at: https://www.health.gov/PAGUIDELINES/pdf/paguide.pdf
8. American Diabetes Association Professional Practice Committee. Cardiovascular disease and risk management: Standards of medical care in diabetes-2022. Diabetes Care. 2022;45(Suppl 1):S144-74. (doi: 10.2337/dc22-S010).
9. Sigal RJ, Armstrong MJ, Colby P, et al. Physical activity and diabetes. Can J Diabetes. 2018;42(Suppl 1):S54-63. (doi:10.1016/j.jcjd.2017.10.008).
10. Chudyk A, Petrella RJ. Effects of exercise on cardiovascular risk factors in type 2 diabetes: A meta-analysis. Diabetes Care.2011;34(5):1228-37. (doi:10.2337/dc10-1881).
11. Kohl HW, Craig CL, Lambert EV, et al. The pandemic of physical inactivity: Global action for public health. Lancet. 2012;380(9838):294-305. (doi:10.1016/S0140-6736(12)60898-8).

12. Xu Y, Wang L, He J, et al. Prevalence and control of diabetes in Chinese adults. JAMA. 2013;310(9):948-59. (doi:10.1001/jama.2013.168118)
13. Latt T-S, Zaw K-K, Ko K, et al. Measurement of diabetes, prediabetes and their associated risk factors in Myanmar 2014. Diabetes Metab Syndr Obes. 2019;12:291-8. (doi:10.2147/DMSO.S156270).
14. Ahmad I, Aung MN, Ueno S, et al. Physical activity of type 2 diabetes mellitus patients and non-diabetes participants in Yangon, Myanmar: A case-control study applying the international physical activity questionnaires (IPAQ-S). Diabetes Metab Syndr Obes. 2021;14:1729-39. (doi:10.2147/DMSO.S291468).
15. Ikechukwu EC, Gloria MU, Ikenna UC, Chinonso UV, Ekezie U, Nkechi C. Physical activity level and factors affecting exercise participation among Nigerian adults with and without diabetes. EMJ. 2020;60:85. (doi:10.33590/emj/20-00214).
16. Ezzati M, Lopez A, Rodgers A, Murray C. Comparative quantification of health risks: Global and regional burden of disease due to selected major risk factors. Geneva: World Health Organization; 2004:729-881.
17. Oyeyemi AL, Kolo SM, Oyeyemi AY, Omotara BA. Neighborhood environmental factors are related to health-enhancing physical activity and walking among community dwelling older adults in Nigeria. Physiother Theory Pract. 2018;35(3):288-97. (doi:10.1080/09593985.2018.1443187).
18. Carlson JA, Sallis JF, Conway TL, et al. Interactions between psychosocial and built environment factors in explaining older adults' physical activity. Prev Med. 2012;54(1):68-73. (doi:10.1016/j.ypmed.2011.10.004).
19. Jáuregui A, Pratt M, Lamadrid-Figueroa H, Hernández B, Rivera JA, Salvo D. Perceived neighborhood environment and physical activity: The international physical activity and environment network adult study in Mexico. Am J Prev Med.2016;51(2):271-9.(doi: 10.1016/j.amepre.2016.03.026).
20. Kubzansky LD, Subramanian SV, Kawachi I, Fay ME, Soobader MJ, Berkman LF. Neighborhood contextual influences on depressive symptoms in the elderly. Am J Epidemiol. 2005;162(3):253-60. (doi:10.1093/aje/kwi185).
21. Yen IH, Michael YL, Perdue L. Neighborhood environment in studies of health of older adults: a systematic review. Am J Prev Med. 2009;37(5):455-63. (doi:10.1016/j.amepre.2009.06.022).
22. Chiang C-C, Chiou S-T, Liao Y-M, Liou YM. The perceived neighborhood environment is associated with health-enhancing physical activity among adults: A crosssectional survey of 13 townships in Taiwan. BMC Public Health. 2019;19:524. (doi:10.1186/s12889-019-6848-4).
23. Saelens BE, Handy SL. Built environment correlates of walking: A review. Med Sci Sports Exerc. 2008;40(7):S550-66. (doi: 10.1249/MSS.0b013e31817c67a4).
24. Owen N, Humpel N, Leslie E, Bauman A, Sallis JF. Understanding environmental influences on walking: Review and research agenda. Am J Prev Med. 2004;27(1):67-76. (doi: 10.1016/j.amepre.2004.03.006).
25. De Bourdeaudhuij I, Sallis JF, Saelens BE. Environmental correlates of physical activity in a sample of Belgian adults. Am J Health Promot. 2003;18(1):83-92. (doi:10.4278/0890-1171-18.1.83).
26. Oyeyemi AL, Sallis JF, Deforche B, Oyeyemi AY, De Bourdeaudhuij I, Van Dyck D. Evaluation of the neighborhood environment walkability scale in Nigeria. Int J Health Geogr.2013;12:16. (doi: 10.1186/1476-072X-12-16).
27. Oyeyemi AL, Kasoma SS, Onywera VO, et al. NEWS for Africa: Adaptation and reliability of a built environment questionnaire for physical activity in seven African countries. Int J Behav Nutr Phys Act. 2016;13:33. (doi:10.1186/s12966-016-0357-y).
28. Van Dam HA, van der Horst FG, Knoops L, Ryckman RM, Crebolder HF, van den Borne BH. Social support in diabetes: A systematic review of controlled intervention studies. Patient Educ Couns. 2005;59(1):1-12. (doi:10.1016/j.pec.2004.11.001).
29. Strom JL, Egede LE. The impact of social support on outcomes in adult patients with type 2 diabetes: A systematic review. Curr Diab Rep. 2012;12(6):769-81. (doi:10.1007/s11892-012-0317-0).
30. Golaszewski NM, Bartholomew JB. The development of the physical activity and social support scale. J Sport Exerc Psychol. 2019;41(4):215-29. (doi:10.1123/jsep.2018-0234).
31. Bauman AE, Reis RS, Sallis JF, Wells JC, Loos RJ, Martin BW. Correlates of physical activity: Why are some people physically active and others not? Lancet. 2012;380(9838):258-71. (doi:10.1016/S0140-6736(12)60735-1).
32. Scarapicchia TMF, Amireault S, Faulkner G, Sabiston CM. Social support and physical activity participation among healthy adults: A systematic review of prospective studies. Int Rev Sport Exerc Psychol. 2017;10(1):50-83. (doi:10.1080/1750984X.2016.1183222).
33. Sherwood NE, Jeffery RW. The behavioral determinants of exercise: Implications for physical activity interventions. Annu Rev Nutr. 2000;20:21-44. (doi:10.1146/annurev.nutr.20.1.21).
34. Tay L, Tan K, Diener E, Gonzalez E. Social relations, health behaviors, and health outcomes: A survey and synthesis. Appl Psychol Health Well-Being. 2013;5(1):28-78. (doi:10.1111/aphw.12000).
35. Trost SG, Owen N, Bauman AE, Sallis JF, Brown W. Correlates of adults' participation in physical activity: Review and update. Med Sci Sports Exerc. 2002;34(12):1996-2001. (doi:10.1097/00005768-200212000-00020).
36. Thoits PA. Conceptual, methodological, and theoretical problems in studying social support as a buffer against life stress. J Health Soc Behav. 1982;23(2):145-59. (doi:10.2307/2136511).
37. Cohen S, Underwood LG, Gottlieb BH. Measuring and intervening in social support. In: Cohen S, Underwood L, Gottlieb B, editors. Social relationships and health. New York, NY: Oxford University Press; 2000. p. 3-25. (doi:10.1093/med:psych/9780195126709.003.0001).
38. Berkman LF, Glass T. Social integration, social networks, social support, and health. In: Berkman LF, Kawachi I, editors. Social epidemiology. New York, NY: Oxford University Press; 2000. p. 158-62.
39. Kasiulevicius V, Sapoka V, Filipaviciute R. Sample size calculation in epidemiological studies. Gerontologija. 2006;7(4):225-31.
40. Janssen I, Katzmarzky PT, Ross R. Body mass index, waist circumference, and health risk: evidence in support of current national institutes of health guidelines. Arch Intern Med. 2002;162(18):2074-9. (doi:10.1001/archinte.162.18.2074).
41. World Health Organization. Physical activity. 2020. Available at: http://www.who.int/news-room/fact-sheets/detail/physical-activity

42. Awotidebe TO, Bisiriyu LA, Ativie RN, et al. Prevalence of physical inactivity among Nigerian women: Do socio-demographic characteristics, women's personal attributes and psychosocial factors play any role? J Exerc Ther Rehabil. 2017;4(1):33-45.
43. Husejko JP, Strugała M, Modrzejewski M, Wąsicki M, Kędziora-Kornatowska K, Podhorecka M. Physical activity of the elderly in light of the 2020 WHO guidelines. Med Rehabil. 2021;25(1):30-6. (doi: 10.5604/01.3001.0014.8724).
44. Sport & Recreation New Zealand (SPARC). The New Zealand physical activity questionnaires: Report on the validation and use of the NZPAQ-LF and NZPAQ-SF self-report physical activity survey instruments. Wellington, New Zealand: SPARC. 2004.
45. Ainsworth BE, Macera CA, Jones DA, et al. Comparison of the 2001 BRFSS and the IPAQ physical activity questionnaires. Med Sci Sports Exerc. 2006;38(9):1584-92. (doi:10.1249/01.mss.0000229457.73333.9a).
46. Scholes S, Bridges S, Ng Fat L, Mindell JS. Comparison of the physical activity and sedentary behaviour assessment questionnaire and the short-form international physical activity questionnaire: An analysis of health survey for England data. PLoS One. 2016;11(3):e0151647. (doi:10.1371 /journal.pone.0151647).
47. van Poppel MNM, Chinapaw MNJ, Mokkink LB, van MechelenW, Terwee CB. Physical activity questionnaires for adults: A systematic review of measurement properties. Sports Medicine. 2010;40(7):565-600. (doi:10.2165/ 11531930-000000000-00000).
48. Lee PH, Macfarlane DJ, Lam TH, Stewart SM. Validity of the international physical activity questionnaire short form (IPAQ-SF): A systematic review. Int J Behav Nutr Phys Act. 2011;8:115. (doi: 10.1186/1479-5868-8-115).
49. Sallis JF, Kerr J, Carlson JA, et al. Evaluating a brief self-report measure of neighborhood environments for physical activity research and surveillance: Physical activity neighborhood environment scale (PANES). J Phys Act Health. 2010;7(4):533-40. (doi: 10.1123/jpah.7.4.533).
50. Sallis JF, Bowles HR, Bauman A, et al. Neighborhood environments and physical activity among adults in 11 countries. Am J Prev Med. 2009;36(6):484-90. (doi:10.1016/ j.amepre.2009.01.031).
51. Edwards P, Roberts I, Clarke M, et al. Increasing response rates to postal questionnaire: Systematic review. BMJ. 2002; 324:1183. (doi:10.1136/bmj.324.7347.1183).
52. Adams MA, Frank LD, Schipperijn J, et al. International variation in neighborhood walkability, transit, and recreation environments using geographic information systems: The IPEN adult study. Int J Health Geogr. 2014;13:43. (doi:10.1186/1476- 072X-13-43).
53. Oyewole OO, Odusan O, Oritogun KS, Idowu AO. Physical activity among type 2 diabetic adult Nigerians. Ann Afr Med. 2014;13(4):189-94. (doi: 10.4103/1596-3519.142290).
54. Shiriyedeve S, Dlungwane TP, Tlou B. Factors associated with physical activity in type 2 diabetes mellitus patients at a public clinic in Gaborone, Botswana, in 2017. Afr J Prim Health Care Fam Med. 2019;11(1):2036. (doi:10.4102/phcfm .v11i.2036).
55. Gatimu SM, Milimo BW, Sebastian MS. Prevalence and determinants of diabetes among older adults in Ghana. BMC Public Health. 2016;16:1174. (doi: 10.1186/s12889-016-3845-8).
56. Donahue KE, Mielenz TJ, Slonane PD, Callahan LF, Devellis RF. Identifying supports and barriers to physical activity in patients at risk for diabetes. Prev Chronic Dis. 2006;3(4):A119.
57. Kriska AM, Saremi A, Hanson RL, et al. Physical activity, obesity and the incidence of type 2 diabetes in a high-risk population. Am J Epidemiol. 2003;158(7):669-75. (doi:10.1093/aje/kwg191).
58. Pati S, Lobo E, Pati S, Desaraju S, Mahapatra P. Type 2 diabetes and physical activity: Barriers and enablers to diabetes control in Eastern India. Prim Health Care Res Dev. 2019;20(e44):1-6. (doi:10.1017/S1463423619000689).
59. World Confederation for Physical Therapy 2017 policy statement: Description of physical therapy. Available at: http://www.wcpt.org/policy/ps-descriptionPT
60. Koetsenruijter J, van Lieshout J, Lionis C, et al. Social support and health in diabetes patients: An observational study in six European countries in an era of austerity. PLoS One. 2015;10(8):e0135079. (doi:10.1371/journal.pone. 0135079).
61. Morowatisharifabad MA, Abdolkarimi M, Asadpour M, Fathollahi MS, Balaee P. Study on social support for exercise and its impact on the level of physical activity of patients with type 2 diabetes. Open Access Maced J Med Sci. 2019;7(1):143-7. (doi:10.3889/oamjms.2019.016).
62. Jaafaripooyan E, Habebo TT, Mosadeghrad AM, et al. The magnitude, types, and roles of social support in diabetes management among diabetics in Southern Ethiopia: A multilevel, multicenter cross-sectional study. Diabetes Metab Syndr Obes. 2021;14:4307-19. (doi:10.2147/DMSO. S332900).
63. Prince SA, Adamo KB, Hamel ME, Hardt J, Gorber SC, Tremblay M. A comparison of direct versus self-report measures for assessing physical activity in adults: A systematic review. Int J Behav Nutr Phys Act. 2008;5:56. (doi:10.1186/1479-5868-5-56).
64. Troiano RP, Berrigan D, Dodd KW, Masse LC, Tilert T, McDowell M. Physical activity in the United States measured by accelerometer. Med Sci Sports Exerc. 2008;40(1):181-8. (doi:10.1249/mss.0b013e31815a51b3).
65. Rzewnicki R, Vanden Auweele Y, De Bourdeaudhuij I. Addressing over reporting on the international physical activity questionnaire (IPAQ) telephone survey with a population sample. Public Health Nutr. 2003;6(3):299-305. (doi: 10.1079/PHN2002427).