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The Mediating Role of Sedentary Behaviour in the Relationship Between Social Support and Depression Among Individuals with Diabetes

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Abstract

Background and objective: The underlying mechanisms for the well-established link between social support and depression remain less understood. This study examined the mediating role of sedentary behaviour (SB) in the relationship between social support (SS) and depression among individuals with diabetes.

Methods: A total of 250 consenting individuals with diabetes attending endocrinology clinic in a Nigerian tertiary hospital were recruited. The International Physical Activity Questionnaire Short Form, Multidimensional Scale of Perceived Social Support, and Center for Epidemiologic Studies Depression Scale were used to collect data on SB, SS and depression respectively. Mediation analysis was performed with hierarchical multiple regression and PROCESS Macro for SPSS. Alpha level was set at $p < 0.05$.

Results: The prevalence of depression among diabetic patients was 30.8%. Social support had a significant negative association with depression and SB, while SB was positively associated with depression ($P < 0.001$). The results showed that SB was a mediator between social support and depression (a*b = -0.151; BCa 95% CI: -0.207 ~ -0.102).

Conclusion: The prevalence of depression was high among Nigerian diabetic patients. In addition, SB has a mediating role in the relationship between social support and depression indicating that SB could reinforce the positive effect of social support on depression.

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Abbreviations:

SB- Sedentary behaviour

PA- Physical activity

SS- Social support

CES-D- Center for Epidemiologic Studies Depression Scale

MSPSS- Multidimensional Scale of Perceived Social Support

IPAQ-SF- International physical activity questionnaire short form

MET- Metabolic Equivalent of Task

HMR- Hierarchical Multiple Regression

1. Introduction

Diabetes is a chronic metabolic ailment characterized by poor glycemic control resulting into several medical, physical and psychosocial complications (Forouhi et al., 2019). The recent epidemiological data showed that about 171 million people are affected by diabetes globally, and this figure is expected to be doubled by year 2030 (Harding et al., 2019). Psychological disorder is a common occurrence in people with chronic illness and is reported to undermine their coping abilities, adherence to treatment regimen and quality of life (Moroianu et al., 2020; Settineri et al., 2019). Diabetes, being one of the most common chronic illnesses, is a known predictor of psychological problems (Barone et al., 2019; Marchini et al., 2018). Many of the psychological disorders in diabetes have been linked to the activation of the innate immune system, increased activation or activity of the hypothalamic–pituitary region, and disease burden of diabetes illness (Garrett & Doherty, 2014). Some of the psychological disorders associated with diabetes in literature include depression, anxiety, poor eating habits, fear, emotional distress, obsessive/compulsive disorders etc. (Kalra et al., 2018). Depression, a common psychological health disorder among the general population which is characterized by persistent unhappiness and apathy to life and daily activities (Teshome et al., 2018), is a major co-morbidity in people living with diabetes (Solomon, 2017), and evidence has shown that depression is more common in diabetic patients than in the general populace (Alosaimi et al., 2019; van Dooren et al., 2013). The global prevalence of depression among patients with diabetes has been reported to be between 18%–25% (Darwish et al., 2018; Papelbaum et al., 2011) while a recent study in one African country reported that about 27.5% of diabetic patients surveyed had elements of depressive symptoms (Ilori et al., 2021).

The effects of depression on patients with diabetes are multifarious and have been enumerated to include increasing risk in mortality and morbidity, low adherence to diabetes treatments, poor quality of life, increase in health care use and expenditure etc. (Egede et al., 2002; Gonzalez et al., 2008; Khaledi et al., 2019; Teshome et al., 2018; Tiki, 2017; van Dooren et al., 2013). However, despite the debilitating effects of depression in diabetes, depression is often overlooked, underdiagnosed and undertreated among individuals with diabetes especially in developing countries (Ekem-Ferguson et al., 2020). Furthermore, although behavioural patterns has been linked with depression in diabetes (Kanapathy & Bogle, 2019) and the introduction of psychosocial therapies in the management of depression in diabetes have shown promising results (Kanapathy & Bogle, 2019; Pampallona et al., 2004), unfortunately, more attention is placed on the biological mechanisms/treatments of depression in diabetes than psychosocial/behavioural mechanisms especially in Sub-Saharan African countries (Ekem-Ferguson et al., 2020).

1.1 Social Support, Sedentary Behaviour and Depression

The psychosocial intervention like social support networks has been highlighted as one of the potent means of tackling depression among patients with diabetes (Ekem-Ferguson et al., 2020). Social support, which broadly includes social structure of an individual and various effects of many interpersonal relationships (Ekem-Ferguson et al., 2020), is a known predictor of depression in patients with diabetes (Strom & Egede, 2012). Evidence have shown that diabetic patients with low social support are more prone to depression, and diabetic patients who undergone psychosocial intervention reported reduction in depressive symptoms (Darwish et al., 2018; Ekem-Ferguson et al., 2020; Kanapathy & Bogle, 2017; Nanayakkara et al., 2018; Pascoe et al., 2017; Sacco & Yanover, 2006).

Meanwhile, depression in diabetes is reported to be positively associated with diabetes-related stress (Fisher et al., 2008, 2014). Diabetes-related stress is a concept related to the burden of diabetes management in which plethora of treatment plan and lifestyle changes are considered as stress by the patients and induces psychological strain (Fischer et al., 2012, 2014; Katon et al., 2010). The Relational Regulation Theory (RRT) propounded that social support serve as buffer to stressful events (stress-buffering hypothesis) experienced by patients especially those of chronic ailments (Ekem-Ferguson et al., 2020; Lakey & Orehek, 2011; Wasserman & Trifonova, 2006). The positive effect of social support on depression in diabetes can be explained by buffering effect offered through social support in countering the diabetes-related stress (Baek et al., 2014; Cohen, 2004; Ekem-Ferguson et al., 2020). Furthermore, research

have shown that social support for diabetic patients helped to promote adaptive strategies like increased optimism, loneliness reduction and self-efficacy in the presence of stressful events leading to lowering in depressive experience (Pascoe et al., 2017; Sacco & Beck, 1995; Southwick et al., 2005).

However, social support is said to influence health not only as stress-buffer but also help to initiate, promote and adhere to healthy behavior (Ekem-Ferguson et al., 2020; Saeedi et al., 2019; Strom & Egede, 2012). Most importantly, social support is reported to be associated with sedentary behaviour (SB) among different populations (Cabanas-Sanchez et al., 2020; Chen et al., 2021; Glonti et al., 2016; Hoenink et al., 2019; Loprinzi & Crush, 2017; Springer et al., 2006). In fact, positive social support has been proven to be associated with lower levels of obesity, a major clinical indicator of SB (Glonti et al., 2016; Hoenink et al., 2019). In addition, like social support, several reports have shown that SB is significantly associated with increased risk of depression in the general populace including diabetic patients (Bélair et al., 2018; Dunstan & Owen, 2021; Henson et al., 2016; Huang et al., 2020; Kandola et al., 2020; Morres et al., 2021; Stubbs et al., 2018).

Meanwhile, SB has been muted as the new behavioral target in mitigating diabetic complications including depression (Henson et al., 2016) as evidence from a prospective study involving about half a million participants has shown causality between high SB and diabetes prevalence and complications (Dunstan & Owen, 2021). Most previous studies have focused mainly on physical activity (PA) as a mediator of depression (Kandola et al., 2020), whereas evidence has shown that SB is associated with depression (Bélair et al., 2018; Dunstan & Owen, 2021; Henson et al., 2016; Huang et al., 2020; Kandola et al., 2020; Morres et al., 2021; Stubbs et al., 2018). It has been reported that many adults spend majority (55%-70%) of their waking hours being sedentary (Henson et al., 2016; Matthew et al., 2008) with individuals with chronic diseases like diabetes in the upper end of this range (Henson et al., 2013). In fact, SB has been reported to be the future true risk factor in public health (der Ploeg & Hillsdon, 2017). A meta-analysis involving more than 1 million people concluded that effect of SB is very hazardous to health and thereby calls for special attention to the deleterious effect of SB in public health interventions (Ekelund et al., 2016).

Consequent to the foregoing, the complex relationships among social support, depression and SB suggest the possibility of both direct and indirect effects of social support on depression. While evidence has shown direct relationship between social support and depression in diabetes through stress-buffering effect, an alternative or indirect pathway between these two

concepts is plausible. The questions are does social support influence SB among diabetic individuals, and does the influence of social support on SB indirectly lead to reduction of depression among diabetic individuals? Although, it has been suggested that interactions of multiple levels of concepts that influence health-enhancing behavior should be investigated (Hoenink et al., 2019), however, most studies do not investigate the complex interplay that may exist among social support, depression, SB; and the relative effect or impact of social support on SB in mitigating depression in diabetic patients. Investigating this interplay is essential as it may show how and by what means an alternative causal effect or relationship between social support and depression occurs. In as much evidence has shown that social support reduces depression in diabetic patients, it may be more informative to know and claim that social support influences depression through SB other than through buffering effects. It is possible that social support rendered to diabetic patients further positively influences health-enhancing behavior vis-à-vis reduction in SB and thereby reduce their symptoms of depression.

1.2 The current study

It is proposed in this study that (1) there will be significant relationship between social support and depression among patients with diabetes, (2) there will be significant relationship between social support and SB among patients with diabetes, (3) there will be significant relationship between SB and depression among patients with diabetes, and (4) the effect of social support on depression will be mediated through SB among patients with diabetes. Understanding the mediating role of SB in the relationship between social support and depression in diabetic patients may help in developing more effective social support and SB strategies in mitigating depression in the future. Therefore, the main objective of the present study was to investigate and provide new empirical data on the form and strength of the possible mediating role of SB in the relationship between social support and depression among individuals with diabetes.

2. Material and method

2.1 Study Design and Respondents

This cross-sectional survey involving patients with diabetes attending the endocrinology clinic of the Osun State University Teaching Hospital, Osogbo, Nigeria was undertaken between March 2021 and February 2022. The purpose of the research was explained to the respondents and their written informed consent was obtained before the commencement of the study. Ethical clearance was obtained from Research Ethics Committee of the Osun State

University Teaching Hospital Osogbo, Nigeria. Patients with Type 1 or 2 diabetes who were 18 years and older were recruited in this study. However, diabetic patients with other conditions or impairments that may hinder physical activity or functional gait/movement e.g. stroke, amputation etc., those with communication and hearing dysfunctions, and those with impaired cognitive function having less than 24 score in Mini Mental State Examination were excluded from the study. The sample size was calculated using the formula for cross-sectional epidemiological survey: $N= Z^2 p (1-p)/ e^2$ (Kasiulevicius et al., 2006). Where: N= required sample size, Z= standard normal deviation (95% confidence level = 1.96), p= pre-study estimate of proportion=10, the prevalence (p) of diabetes in Nigeria which has been estimated to be 10% (Ogbera & Ekpebegh, 2014), while e= the desired level of precision (0.05). $N=1.96^2\times10(1-10)/0.05^2 = 125$. Therefore, a minimum of 125 respondents were required for this study. However, in order to double the statistical power of the study, a total of 250 respondents were consecutively recruited.

2.2 Assessments

2.2.1 Depression

The level of depressive symptoms of the respondents was evaluated by the Center for Epidemiologic Studies Depression Scale (CES-D). The CES-D is one of the most commonly used and best supported tools in the screening of depression among patients with diabetes (van Dijk et al., 2018; Zhang et al., 2015). It includes twenty items consisting six scales reflecting main issues of depression including depressed mood, feelings of guilt and worthlessness, feelings of helplessness and hopelessness, psychomotor retardation, loss of appetite, and sleep disturbance that occur in the previous week. Each item on CES-D is rated on a 4-point scale ranging from 0 (rarely or none of the time) to 3 (most or all of the time). The total score of CES-D ranges from 0 to 60 with higher score indicate a greater chance of depression. A cutoff of 16 or greater was used to indicate presence of depressive symptoms in this study (Darwish et al., 2018).

2.2.2 Social Support

The Multidimensional Scale of Perceived Social Support (MSPSS) was used to assess the social support of the respondents. The MSPSS has evolved over time as one of the most common and frequently used measure of social support (Dambi et al., 2018; Hannan et al., 2016). The instrument has 12 items that assess the perceived adequacy of the available amount of social support (Dahlem et al., 1991; Zimet et al., 1988). The MSPSS assesses the amount of social

support received by a person from three sources including friends, family and significant other/special person. The perceived social support received by an individual is rated on a7-point Likert scale ranging from very strongly disagree (1 point) to very strongly agree (7 points). The cumulative scores of MSPSS ranges from 12 to 84 with higher score indicating a greater amount of available social support (Dahlem et al., 1991). The psychometric properties of MSPSS have been established as adequate among patients with chronic illness (Maddalena et al., 2018) including those with diabetes (Park et al., 2012). In this study, the respondents' amount of available social support was further categorized into 3 levels. Respondents with less than 42 scores on MSPSS (< 50% MSPSS score), with 42 to 63 scores on MSPSS (50-75% MSPSS score), and those with more than 63 scores on MSPSS (>75% MSPSS score) were categorized as having low, moderate and high social support respectively.

2.2.3 Sedentary Behaviour

The self-reported SB of the respondents was assessed by the International physical activity questionnaire short form (IPAQ-SF). The SB (time spent sitting) was evaluated from the single-item "During the last 7 days, how much time did you usually spend sitting on a weekday" of the IPAQ-SF. The "time spend sitting on weekdays" include "time spent at work, at home, while doing course work and during leisure time. This may also include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television" (IPAQ, 2004). In this study, respondents with sitting time ≥ 540 minutes per weekday were considered as being sedentary (Scholes et al., 2016).

2.3 Covariates

2.3.1 Socio-demographic Characteristics

Information on socio-demographic and clinical (age, sex, body mass index, waist circumference, time since diagnosis of diabetes, history of alcohol intake and cigarette smoking, employment, marital, education status, and income level) characteristics of the respondents was obtained through a self-developed proforma. Marital status was categorized as married or single while age was categorized into ≤ 64 years or 65 years or older. Respondents were classified as being employed or unemployed. The education status was categorized as low (education up to secondary/diploma level) or high (first degree or higher). The income level was categorized into low (< $2 per day), medium ($2-$5 per day) and high (>$5 per day). The waist circumference was assessed at the midpoint between the iliac crest and the lower costal margin with a non-stretch tape. Waist circumference values ≤ 102cm and ≤ 88cm were categorized as normal in male and female respondents (Janssen et al., 2002).

2.3.2 Physical Activity

The International physical activity questionnaire short form (IPAQ-SF) was used to assess the reported PA of the respondents. The IPAQ-SF with 7 items elicit information on the number of days and average time per day an individual spent on PA including vigorous-intensity activity, moderate-intensity activity, and walking activity performed for at least 10 minutes at a time in the past week. This instrument is well validated and adjudged reliable in PA assessment in the general population (van Poppel et al., 2010). The intensity of each domain of PA in IPAQ-SF was determined by using the Metabolic Equivalent of Task (MET) scores of each domain. The MET equivalent to each domain; vigorous PA (MET = 8.0), moderate PA (MET = 4.0), and walking (MET = 3.3) was calculated by multiply the total minutes and days of PA within a week by the MET of the respective domain. The total amount of PA of the respondents was determined by summing up all the METs from the 3 domains of IPAQ-SF and was then classified into low (<600 MET-min per week), moderate (≥600 MET-min per week) and high (≥3000 MET-min per week) PA following established protocols on IPAQ-SF scoring and global PA recommendations (Chiang et al., 2019; WHO, 2010; 2020). The second item on IPAQ-SF was reordered as item 1 and vice-versa in this study to remove or reduce the possibility of PA overestimation. This protocol was thoroughly explained elsewhere (Ainsworth et al., 2006; Scholes et al., 2016; SPARC, 2004).

2.4 Data analysis

Descriptive statistics of frequency, percentage, mean and standard deviation was used to summarize data obtained. Chi-square test of association was used to investigate factors associated with depression, while Pearson correlation was conducted to examine the relationships among depression, SB and social support. The Hierarchical Multiple Regression (HMR) was employed to investigate the predictors of depression and mediating effect of SB on the relationship between social support and depression. Also, the asymptotic and resampling protocols of Preacher and Hayes were used to evaluate the mediating effect of SB on the relationship between social support and depression (Preacher & Hayes, 2004, 2008) with depression serving as the dependent variable. The independent variables were entered in HMR models in three stages as follow; Stage 1: The socio-demographic variables that were significantly associated with depression in the bivariate analysis, and the total PA of the diabetic patients; stage 2: Social support; and stage 3: Sedentary behaviour. According to the protocols, if after adding SB to the model and the regression coefficient of depression is decreased and significant from stage 2 to 3, then partial mediation is indicated. However, if the

regression coefficient of depression is not significant from stage 2 to 3, then complete mediation is indicated. Furthermore, the significance of the potential mediation of SB in the relationship between social support and depression was evaluated by Sobel test and a bias-corrected and accelerated 95% confidence interval (CI) (BCa 95% CI) bootstrapping test with the estimate of 5,000 samples. Alpha level was set at $p < 0.05$. Data analysis was carried out using SPSS 21.0 version (SPSS Inc., Chicago, Illinois, USA) and PROCESS Macro for SPSS version 4.0 by Andrew F. Hayes.

3. Results

The general characteristics of the respondents are presented in Table 1. The mean and standard deviation of the respondents' age, body mass index, and MSPSS were 58.36±12.32 years, 26.77±4.23 kg/m^2, and 66.10±20.55 respectively. Many (76.4%) of the respondents were married and had low educational level (58.0%) and were overweight or obese (58.8%). A total of 44.0%, 32.0% and 24.0% of the respondents had low, medium and high-income level respectively, while 68.4% and 51.6% of the respondents had high social support and low PA level. The prevalence of depression and SB was 30.8% and 17.2%. The results of chi-square test of associations of depression, PA, SB and social support with the socio-demographic characteristics of the respondents are presented in Table 2. The results indicated that the depressive symptoms was significantly associated with each of age ($X^2 = 7.697$; $p = 0.006$), sex ($X^2 = 4.622$; $p = 0.032$), level of education ($X^2 = 19.221$; $p < 0.001$), level of income ($X^2 = 7.142$; $p = 0.028$), marital status ($X^2 = 22.886$; $p < 0.001$), employment status ($X^2 = 6.438$; $p = 0.011$), and diabetes duration ($X^2 = 11.151$; $p = 0.001$), while PA was significantly associated with each of age ($X^2 = 12.655$; $p = 0.002$), level of education ($X^2 = 42.875$; $p < 0.001$), level of income ($X^2 = 15.869$; $p = 0.003$), marital status ($X^2 = 7.149$; $p = 0.028$), employment status ($X^2 = 11.530$; $p = 0.003$), body mass index ($X^2 = 16.368$; $p < 0.001$), waist circumference ($X^2 = 20.394$; $p < 0.001$), and alcohol intake ($X^2 = 7.845$; $p = 0.020$).

Moreover, the SB of the respondents was significantly associated with each of level of education ($X^2 = 14.167$; $p = 0.003$), level of income ($X^2 = 19.681$; $p < 0.001$), marital status ($X^2 = 7.314$; $p = 0.007$), employment status ($X^2 = 4.282$; $p = 0.039$), measure of abdominal obesity (waist circumference) ($X^2 = 12.958$; $p = 0.002$), diabetes duration ($X^2 = 21.924$; $p < 0.001$), and alcohol intake ($X^2 = 4.029$; $p = 0.049$). In addition, social support was associated with the respondents' level of education ($X^2 = 29.617$; $p < 0.001$), income level ($X^2 = 35.313$; $p < 0.001$), marital status ($X^2 = 51.909$; $p < 0.001$), employment status ($X^2 = 11.783$; $p = 0.003$), and diabetes duration ($X^2 = 17.702$; $p < 0.001$) (Table 2).

Table 1. General characteristics of the respondents (N=250)

Variables	Number	Percentages
Age (≤ 64 years)	179	71.6
Sex (female)	147	85
Education level (low)	145	58.0
Income level (low)	110	44.0
Marital status (married)	191	76.4
Employment (employed)	170	68.0
BMI (BMI≥25.0)	147	58.8
Waist circumference (WC) (above normal WC)	183	73.2
Diabetes duration (≤10 years)	203	81.2
Positive hx of smoking (No)	246	98.4
Positive hx of alcohol (No)	232	92.8
Social support		
Low	33	13.2
Moderate	46	18.4
High	171	68.4
Physical activity		
Low	129	51.6
Moderate	72	28.8
High	49	19.6
Sedentary behaviour		
Yes	43	17.2
No	207	82.8
Depression status		
Yes	77	30.8
No	173	69.2

Table 2. Associations of depression, physical activity, sedentary behaviour and social support with the socio-demographics of the respondents (N =250)

Variables n(%)	Depression		Physical activity			Sedentary behaviour		Social Support		
	Yes	No	Low	Moderate	High	Yes	No	Low	Moderate	High
Age										
≤64	46 (18.4)	133 (53.2)*	80 (32.0)	57 (22.8)	42 (16.8)*	32 (12.8)	147 (58.8)^{ns}	20 (8.0)	31 (12.4)	128 (51.2)*
≥65	31(12.4)	40(16.0)	49(19.6)	15(6.0)	7(2.8)	11(4.4)	60(24.0)	13(5.2)	15(6.0)	43(17.2)
Sex										
Male	24 (9.6)	79 (31.6)*	53 (21.2)	27 (10.8)	23 (9.2)^{ns}	19 (7.6)	84 (33.6)^{ns}	8 (3.2)	19 (7.6)	76 (30.4)^{ns}
Female	53 (21.2)	94 (37.6)	76 (30.4)	45 (18.0)	26 (10.4)	24 (9.6)	123 (49.2)	25 (10.0)	27 (10.8)	95 (38.0)
Education level										
Low	60 (24.0)	86 (34.4)*	100 (40.0)	26 (10.4)	20 (8.0)**	36 (14.4)	110 (44.0)*	31 (12.4)	23 (9.2)	92 (36.8)**
High	17(6.8)	87(34.8)	29(11.6)	46(18.4)	29(11.6)	7(2.8)	97(38.8)	2(0.8)	23(9.2)	79(31.6)
Income level										
Low	43 (17.2)	67 (26.8)*	67 (26.8)	24 (9.6)	19 (7.6)*	31 (12.4)	79 (31.6)**	28 (11.2)	22 (8.8)	60 (24.0)**
Medium	17(6.8)	63(25.2)	31(12.4)	25(10.0)	24(9.6)	3(1.2)	77(30.8)	2(0.8)	8(3.2)	70(28.0)
High	17(6.8)	43(17.2)	31(12.4)	23(9.2)	6(2.4)	9(20.4)	51(20.4)	3(1.2)	16(6.4)	41(16.4)
Marital status										
Married	44 (17.6)	147 (58.8)**	94 (37.6)	63 (25.2)	34 (13.6)*	26 (10.4)	165 (66.0)*	9 (3.6)	36 (14.4)	146 (58.4)**
Single[a]	33(13.2)	26(10.4)	35(14.0)	9(3.6)	15(6.0)	17(6.8)	42(16.8)	24(9.6)	10(4.0)	25(10.0)
Employment status										

Employed	61 (24.4)	109 (43.6)*	100 (40.0)	40 (16.0)	30 (12.0)*	35 (14.0)	135 (54.0)*	31 (12.4)	29 (11.6)	110 (44.0)*
Unemployed	16(6.4)	64(25.6)	29(11.6)	32(12.8)	19(7.6)	8(3.2)	72(28.8)	2(0.8)	17(6.8)	61(24.4)
BMI										
Normal	28 (11.2)	75 (30.0)^{ns}	53 (21.2)	19 (7.6)	31 (12.4)**	20 (8.0)	83 (33.2)^{ns}	17 (6.8)	15 (6.0)	71 (28.4)^{ns}
Overweight/obesity	49 (19.6)	98 (39.2)	76 (30.4)	53 (21.2)	18 (7.2)	23 (9.2)	124 (49.6)	16 (6.4)	31 (12.4)	100 (40.0)
Waist circumference										
Normal	24 (9.6)	43 (17.2)^{ns}	38 (15.2)	7 (2.8)	22 (8.8)**	21 (8.4)	46 (18.4)*	16 (6.4)	8 (3.2)	43 (17.2)*
Excessive	53 (21.2)	130 (52.0)	91 (36.4)	65 (26.0)	27 (10.8)	22 (8.8)	161 (64.4)	17 (6.8)	38 (15.2)	128 (51.2)
Diabetes duration										
≤ 10 years	53 (21.2)	150 (60.0)*	99 (39.6)	59 (23.6)	45 (18.0) ^{ns}	24 (9.6)	179 (71.6)**	18 (7.2)	39 (15.6)	146 (58.4)**
> 10 years	24(9.6)	23(9.2)	30(12.0)	13(5.2)	4(1.6)	19(7.6)	28(11.2)	15(6.0)	7(2.8)	25(10.0)
Smoking										
Yes	2(0.8)	2(0.8)^{ns}	0(0.0)	3(1.2)	1(0.4) ^{ns}	0(0.0)	4(1.6) ^{ns}	0(0.0)	1(0.4)	3(1.2) ^{ns}
No	75 (30.0)	171 (68.4)	129 (51.6)	69 (27.6)	48 (19.2)	43 (17.2)	203 (81.2)	33 (13.2)	45 (18.0)	168 (67.2)
Alcohol Intake										
Yes	2 (0.8)	16 (6.4)^{ns}	15 (6.0)	2 (0.8)	1 (0.4)*	0 (0.0)	18 (7.2)*	0 (0.0)	1 (0.4)	17 (6.8)*
No	75 (30.0)	157 (62.8)	114 (45.6)	70 (28.0)	48 (19.2)	43 (17.2)	189 (75.6)	33 (13.2)	45 (18.0)	154 (61.6)

Key: [a]-included the unmarried, divorced or widowed; ns-non-significance at $p<0.05$; * significance at $p<0.05$; **significance at $p<0.001$

As shown in Table 3, social support was negatively correlated with depression ($r = -0.48$; $p < 0.001$) and SB ($r = -0.33$; $p < 0.001$). There was a positive correlation between SB and depression ($r = 0.50$; $p < 0.001$), but a negative correlation between SB and PA ($r = -0.36$; $p < 0.001$). The increase in social support score led to the decrease in depression score, while increase in SB score of the respondents, the degree of depression increases (Table 3). The HMR models of depression in diabetic patients are presented in Table 4. The results showed that 56.3% of the variance observed in depression in this cohort was explained by the final model of HMR. Age and marital status were significantly associated with depression in all the three models, while PA was significantly associated with depression in models 1 and 2. The change in R^2 showed that social support contributed about 16.4% in the depression variance, while SB contributed 14.5% to the total variance of depression in diabetic patients. In addition, social support was a negative predictor of depression, and SB was a positive predictor of depression.

Table 3: The Pearson correlation among depression, physical activity, sedentary behaviour, social support and other factors

Variable	1	2	3	4	5	6	7
Depression	1						
Total physical activity (METs)	-0.22**	1					
Sedentary behavious	0.50**	-0.36**	1				
Social support	-0.48**	0.26**	-0.33**	1			
Age	0.08	-0.29**	0.06	-0.17**	1		
Income	-0.25	0.04	-0.15	0.36**	-0.14**	1	
Diabetes duration	0.20	0.10	0.13**	-0.14**	0.23**	-0.14	1

Key: METs-metabolic equivalents; ** indicates significance correlation at $p < 0.001$.

Table 4. The Hierarchical Multiple Regression Models of Depression in Diabetes

	Model 1			Model 2			Model 3		
	B	B	95%CI	B	β	95%CI	B	B	95%CI
Block 1									
Age (≤64 years vs. ≥65 years)	4.48*	0.13*	0.373~8.590	4.84*	0.14*	1.207~8.480	6.14**	0.18**	2.966~9.30
Sex (Male vs. Female)	1.21	0.04	-2.612~5.029	0.86	0.03	-2.521~4.242	1.78	0.06	-1.161~4.72
Education (Low vs. High)	-0.55	-0.05	-1.707~0.617	-0.61	-0.06	-1.636~0.421	-0.70	-0.07	-1.591~0.19
Income (Naira)	-3.16*	-0.18*	-5.773~1.261	-1.53	-0.078	-3.665~0.609	-0.99	-0.05	-2.867~0.88
Marital status (Married vs. Single)	11.86**	0.32**	7.675~16.044	6.43*	0.18*	2.503~10.351	6.64**	0.18**	3.235~10.05
Employment status (Employed vs. unemployed)	-7.47**	-0.22**	-11.620~3.321	-5.35*	-0.16*	-9.056~1.643	-1.93	-0.06	-5.234~1.37
Diabetes duration (≤ 10 years vs. > 10 years)	3.93	0.10	-0.799~8.648	-0.74	-0.02	-5.069~3.583	-2.89	-0.07	-6.682~0.89
Total PA (METs)	-4.82**	-0.24**	-7.061~-2.569	-2.86*	-0.14*	-4.986~-0.736	-0.93	-0.05	-2.838~0.99
Block 2									
Social support				-0.36**	-0.47**	-0.444~-0.272	-0.23**	-0.30**	-0.309~-0.14
Block 3									
Sedentary behaviour (minutes)							0.04**	0.45**	0.029~0.04
R^2	0.254			0.419			0.563		
Adjusted R^2	0.230			0.397			0.545		
Change in R^2	0.254			0.164			0.145		

Key: METs- metabolic equivalents; * significance at $p < 0.05$; ** significance at $p < 0.001$.

The mediating role of SB in the relationship between social support and depression evaluated by SPSS PROCESS Macro regression models was depicted in Figures 1 and 2. The path diagram shown in figure 1 indicated a significant total effect of social support on depression (c = B = -0.439; t(248) = 16.196, p < 0.001). The path analysis implied that social support had a negative association with depression. As shown in Figure 2, SB was significantly and negatively associated with social support (a = B = -4.219; t(248) = 15.271, p < 0.001). Furthermore, when SB was introduced as mediator in the model, the path coefficient of effect of social support on depression reduced significantly (c' = B = -0.286; t(247) = -7.384, p < 0.001) confirming the partial mediating effect of SB, while SB was positively associated with depression (b = B = 0.036; t(247) = 8.795, p < 0.001). The significance of partial mediation of SB in the relationship between social support and depression was tested and confirmed by Sobel test (a*b = -0.151; z = -5.963; p < 0.001) and bias-corrected and accelerated bootstrap (a*b = -0.151; BCa 95% CI: -0.207 ~ -0.102).

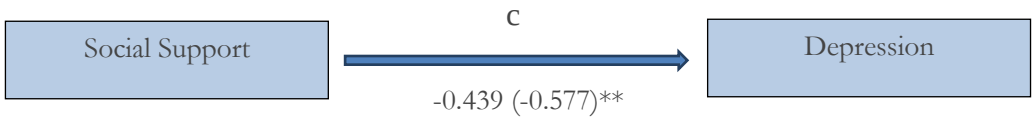

Figure 1. Path diagram of total effect of social support on depression. ** indicates that the standardized and unstandardized coefficient paths are significant at p < 0.001. Note: The standardized coefficient is in bracket.

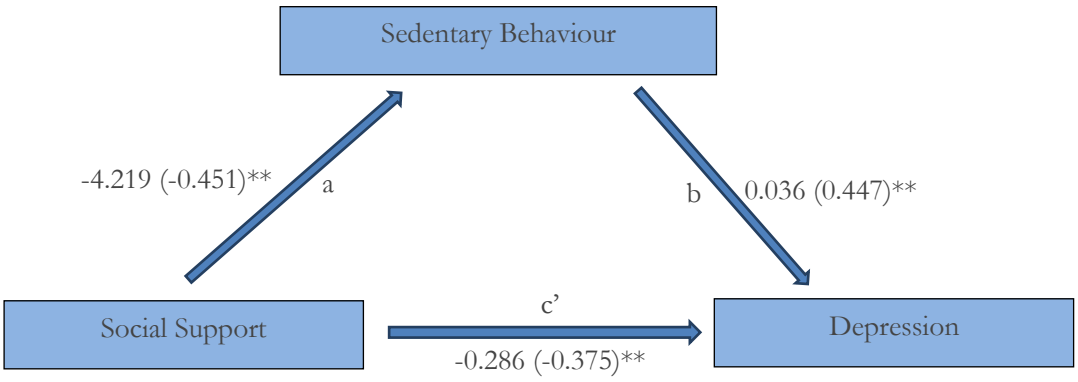

Figure 2. The path diagram illustrating the mediating role of sedentary behaviour in the relationship between social support and depression. ** indicates that the standardized and unstandardized coefficient paths are significant at p < 0.001. Note: The standardized coefficients are in bracket.

Unstandardized path	Standardized path
Total effect c = -0.439	Total effect c = -0.577
Direct effect c' = -0.286	Direct effect c' = -0.375
Indirect effect (a*b) = -0.151	Indirect effect (a*b) = -0.201

4. Discussion

Diabetes as a chronic illness is often accompanied with psychological disorders especially depression. The presence of depression in individuals with diabetes comes with several deleterious effects including no or poor adherence to treatment, poor glycaemic control and increased numbers of diabetes complications (Barone et al., 2019; Garrett & Doherty, 2014; Marchini et al., 2018; Moroianu et al., 2020; Settineri et al., 2019). Psychological stress which has been mentioned as the main etiology of depression in people with diabetes (Garrett & Doherty, 2014) is easily remedied through effective social support and social networks (Ekem-Ferguson et al., 2020). However, the mechanisms at which social support influences positive effects on depression in patients with diabetes still remain less understood. Meanwhile, SB which has been described as future public health concern (der Ploeg & Hillsdon, 2017), is known to be associated with both social support and depression among individuals with diabetes and it is reported to possibly have common aetiolgy with depression and diabetes (Darwish et al., 2018; Dunstan & Owen, 2021; Henson et al., 2016). Considering the importance of psychosocial interventions in curbing the burden of psychological disorders in diabetes, it is imperative to evaluate the complex interplay among these concepts. Thus, this study was primarily aimed to investigate the form and strength of the possible mediating role of SB in the relationship between social support and depression among individuals with diabetes.

The findings of this study showed that social support is inversely related to depression, which is consistent with the reports of previous studies (Darwish et al., 2018; Ekem-Ferguson et al., 2020; Kanapathy & Bogle, 2019; Nanayakkara et al., 2018; Pascoe et al., 2017; Sacco & Yanover, 2006; Strom & Egede, 2012). In addition, the results showed that SB partially mediates the relationship between social support and depression among individuals with diabetes. This study, to our knowledge, is the first that has identified SB as a potential mediator through which social support exert anti-depressant effect especially among clinical population like diabetic individuals. This indicates that while social support may reduce

depressive symptoms among diabetic patients through stress-buffering effect, it may also trigger health-enhancing behaviour like reduction in SB and thereby indirectly modulate depression. Like social support, the results also showed that SB inversely mediates depression implying that the mediating effect of SB on depression among the cohort investigated could be additive and therefore beneficial.

Like social support, SB is a known predictor of depression in many populations and clinical conditions (Bélair et al., 2018; Dunstan & Owen, 2021; Henson et al., 2016; Huang et al., 2020; Kandola et al., 2020; Morres et al., 2021; Stubbs et al., 2018). Therefore, the mediating role of SB in the relationship between social support and depression is warranted. Several reports have identified PA as a proven means of relieving depression, however, it has been postulated that increasing in SB displaces PA participation of an individual and the attendant anti-depressant effect of PA which may result into increased risk of depression (Biddle & Asare, 2011; Teychenne et al., 2010; Zhai et al., 2015). Another plausible explanation offered in the relationship between SB and depression is the social withdrawal hypothesis which postulates that individuals with increasing SB are isolated and removed from the positive effect of social interactions and networks and thereby precipitate or worsen their depressive symptoms (Kraut et al., 1998; Teychenne et al., 2010). These hypotheses were further confirmed in this study as SB was negatively associated with PA and social support of the diabetic patients suggesting that higher SB led to reduction in PA participation and available social support. In summary, it could be inferred that individuals with high SB spend less time socializing and engaging in PA and are therefore more prone to depression.

5. Clinical implications

The findings of this study have some relevant practical implications. This study tries to show the mediating effect of SB on the relationship between depression and social support. We attempt to capture the magnitude of indirect effect of social support on depression through SB among diabetic patients. The relationship between SB and depression have been extensively debated by various researchers (Bélair et al., 2018; Biddle &Asare, 2011; Dunstan & Owen, 2021; Henson et al., 2016; Huang et al., 2020; Kandola et al., 2020; Morres et al., 2021; Stubbs et al., 2018; Teychenne et al., 2010; Zhai et al., 2015), however, many gaps still exist on how social support may influence SB, and the empirical data on the influence of social support on depression through SB. The available data in the area of social support and SB are sparse (Cabanas-Sanchez et al., 2020; Loprinzi & Crush, 2017; Sawka et al., 2013), and dwell mostly on apparently healthy individuals but diabetic patients were taken as respondents

in the present study. Thus, the present results can be applied to population with chronic diseases who are prone to depression. The results of this study suggest that conscious efforts need to be made to provide and encourage support networks among diabetic patients, and they should also be provided with social support-seeking skills as it emerged that social support not only serve as stress-buffer for diabetic-related stress but also encourage less SB in mitigating depression. This is important as evidence has shown that breaking sitting time may reduce diabetic complications including depression, and policy makers and clinicians have been advised to design lifestyle approaches in reducing SB (Henson et al., 2016). A good starting point in reducing SB may be to implement, reinforce and promote available social support system especially for this cohort. Furthermore, clinicians and policy makers may need to develop and introduce social support system specific to SB as none is available presently. Simple modifications in workplace like provision of standing work stations, and incorporation of active breaks including brief bouts of light-intensity activities within working hours have been proposed as a form of social support in breaking sedentary time in occupational setting (Bailey & Locke, 2015; Thivel et al., 2018). Therefore, all the five elements (emotional, validation, informational, companionship, and instrumental) of social support and the most appropriate social support systems or elements suitable for different settings may have to be considered and integrated to effectively reduce SB.

It appears that some socio-demographic characteristics of individuals with diabetes like age and marital status may be considered in developing social support strategies for SB in enhancing the positive effect of social support on psychological disorder in diabetes especially depression. Age and marital status were consistently and positively associated with depression even after the inclusion of social support and SB in the second and third models of HMR. The single (the unmarried, widowed and separated) and younger individuals with diabetes may present with different experience and effect of social support on depression and SB and therefore possibly show different form or strength of indirect effect of social support on their depressive symptoms. This indicates that health professionals may have to consider the influence of ageing, living conditions, cohabitations etc. in formulating social support networks or groups, evaluation of availability of social support, type of social support needed etc. for this category of patients and those with similar psychological disorder following chronic illness. Previous reports had highlighted that individuals perceive or interpret social support differently based on the recipient's socio-demographic characteristics and socio-cultural practices (Strom & Egede, 2012).

6. Strengths and limitations

Apart from contributing to literature on the concepts of social support, depression and SB in diabetes, our study is among the first to investigate the potential mediating effect of SB in the relationship between social support and depression in individuals with diabetes. Another main strength of this study is the use of a large sample of individuals with both Type 1 or 2 diabetes mellitus which are likely to be the true representative of patients attending a typical diabetes clinic in Nigeria and sub-Saharan Africa, and also allowing for comparison across sub-groups including age, gender etc. Furthermore, contrary to most previous studies which often treat SB as a dichotomous variable, we employed measure of SB which allowed us to treat SB as both continuous and dichotomous variable thereby helping us to shed better light on these relationships among individuals with diabetes. These strengths notwithstanding, the findings of this study have some potential limitations. The potential problem of recall bias may affect the responses on the questionnaires employed to assess depressive symptoms, social support, and SB. We did not evaluate whether different sources (family, friends and others) and different elements (emotional, validation, informational, companionship, and instrumental) of social support may influence SB differently or if the different types of SB (passive or active) may present with different mediating roles. In addition, as this is a cross-sectional study, this study cannot rule-out different/alternative path or direction in the relationships among social support, depression and SB. Prospective studies employing the use of objective measure of SB (e.g., the use of accelerometer) may be needed to further investigate the mediating role of SB in the relationship between social support and depression.

7. Conclusion

The prevalence of depression was high among Nigerian diabetic patients. In addition, SB has a mediating role in the relationship between social support and depression indicating that SB could reinforce the positive effect of social support on depression.

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Authors' contribution: ABA was involved in the design of the study. OEA, IAA, and OIA were involved in data collection. ABA, CEM, and TOA were involved in data analysis and interpretation. ABA composed the original manuscript. ABA, OEA, IAA, OIA, CEM, and TOA contributed to the written of the final manuscript.

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