Does Heterogeneity of Depression Matters in the Nexus Between Sedentary Behaviour and Depression Among Patients with Diabetes?

Running Title: Heterogeneity of Depression in Diabetes

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, Manchester Metropolitan University, Manchester, UK

*Corresponding author: Adekola B. Ademoyegun, Department of Physiotherapy, Osun State University Teaching Hospital, PMB 5000, Osogbo, Nigeria. E-mail: aademoyegun@gmail.com

Abstract

Background: Depression and sedentary behaviour (SB) are prevalent co-morbidities of diabetes. However, heterogeneity of depression complicates understanding the SB and depression nexus. This study investigated the associations of SB with depression and the four dimensions of depressive symptoms (negative affect, positive affect, somatic symptoms and interpersonal problems), as well as the moderating effect of gender among patients with diabetes.

Methods: A total of 351 diabetes patients attending endocrinology clinic in a Nigerian tertiary hospital had their SB and depressive symptoms assessed with the use of the International Physical Activity Questionnaire Short Form and Center for Epidemiologic Studies Depression Scale (CES-D).

Results: There was positive association between SB and total CES-D score, and separate and non-uniform positive associations of SB with the four dimensions of depression. Of all the dimensions of depression, somatic symptoms had the strongest association with SB. The impact of SB on overall depression and on negative affect, positive affect, and interpersonal problems was significantly higher in women than men.

Conclusions: These findings suggest that all dimensions of depression present with distinct link with SB. Overall, the impact of SB on depression was more likely to be expressed as somatic symptoms than any other dimension of depression. Furthermore, the influence of SB on depressive symptoms differed by gender in patients with diabetes. Thus, breaking SB may reduce depressive symptoms especially somatization in patients with diabetes while gender-specific strategies may be warranted to tackle impact of SB on depression in diabetes.

Keywords: Diabetes; Emotional disorders; Sitting time; Somatic symptoms; Physical activity

Introduction

Depression is a prevalent co-morbidity of diabetes[1,2] with a rate of 18-25% globally.[3] Similarly, sedentary behaviour (SB) is common among individuals with diabetes[4] and it constitutes a public health risk.[5] Meanwhile, there is apparent misunderstanding and misapplication of concepts of physical activity (PA) and SB where many have erroneously equated physical inactivity to sedentary lifestyle.[5] Although SB and PA are reported as phenomena from the same energy expenditure spectrum, physical inactivity indicate a situation when an individual fail to reach PA recommendations whereas SB is defined as sitting, lying or reclining positions without any muscular contractility. Besides, empirical data suggest that PA and SB have different correlates and effects on health indices.[5] Most adults with diabetes spend up to 70% of their waking hours being sedentary.[4, 6] Thus, the co-occurrence of depression and SB in individuals with diabetes has led to overlapping or increasing negative health outcomes and morbidity.[7-9]

There is substantial literature on the pattern of co-occurrence of SB and depression in apparently healthy and other disease populations, compared with individuals with diabetes.[10] Meanwhile, depression has been reported to be condition-specific or unique in its etiology and phenotypical expression.[11, 12] Some symptoms of depression are reported to be specific to diabetes than observed in non-diabetic populations.[3] Accordingly, there seems to be peculiar nexus between depression and SB in patients with diabetes compared to the healthy general populace.[1, 2, 4] Therefore, the pattern and strength of correlation between SB and depression found among other apparently healthy populations may not be extrapolated to those with chronic ailment like diabetes. To our knowledge, only one study had examined the relationship between SB and depression in adults with diabetes.[10] The study found a significant relationship between SB and depression;

however, the external validity of the study was limited by small sample size. Thus, inviting the need for substantial data that may help to understand depression and SB nexus in diabetes.

Meanwhile, the heterogeneity of depressive symptoms has been reported as another problem militating against robust understanding of the relationship between SB and depression.[13] Studies investigating the relationship between depression and SB have utilized measures that characterize depression as a composite summary score in which the levels and presence of depressive symptoms were summed up,[13-18] whereas it has been shown that depression has different dimensions and can therefore manifest singly or in combination of emotional, physical, cognitive, or social symptoms presenting with different phenotypes and aetiological causes.[11, 12, 19] A study had previously showed that the different dimensions of depressive symptoms separately and uniquely predicted the risk of engaging in non-health enhancing behaviour of smoking,[20] therefore suggesting that different dimensions of depression may relate uniquely or differently to SB. Furthermore, Gotlib and Hammen have shown that the use of composite score for depressive symptoms may hide the most relevant theoretical or clinical variability and understanding of depression.[21] Therefore, investigating the relationship of SB with different symptoms of depression may provide better hints on the specific link between the two concepts and enable clinicians to better understand specific factors responsible for the increasing in depression and SB among individual adults with diabetes. Till date, to our knowledge, only two studies have investigated the relationship of different dimensions of depression and SB and these studies involved only healthy children and adolescents populations.[13, 22] There seems to be no study that has investigated the relationship of different dimensions of depressive symptoms with SB in the adult population especially among those living with diabetes. Thus, the present study was aimed to assess the associations of SB with depression and different dimensions of depressive symptoms

(negative affect, positive affect, somatic symptoms, and interpersonal problems), as well as the moderating effect of gender in adults with diabetes.

Methods

Respondents

This study was part of the project evaluating relationships among SB, depression, physical activity and social support in adults with diabetes. The cross-sectional observational survey involved patients with diabetes attending the endocrinology clinic of the Osun State University Teaching Hospital, Osogbo, Nigeria between March 2021 and June 2022. The ethical approval was obtained from the Research Ethics Committee of the Osun State University Teaching Hospital Osogbo, Nigeria. Also, written informed consent was obtained from each respondent. Eligible respondents were patients with diabetes (Type 1 or 2) who were 18 years and older, who had no cognitive impairment, and had a Mini Mental State Examination (MMSE) score of no less than 24. Respondents with physical disability and other medical condition that can inhibit functional activity, confine the respondents to bed or restrict their social and physical participations leading to or aggravating sedentary lifestyle (e.g. stroke), and those with communication and hearing impairments were excluded. Based on a sample size formula by Kasiulevicius et al. sample size formula,[23] using the prevalence of depression among Nigerian adults with diabetes as 27.5%,[24] 95% confidence level and 0.05 precision level, a sample of 345 was calculated for this study. A total of 351 patients with diabetes participated in the study.

Measures

Sedentary Behaviour

The International physical activity questionnaire short form (IPAQ-SF) was employed to assess the self-reported SB of the respondents. The time spent sitting was assessed from the IPAQ-SF single item "During the last 7 days, how much time did you usually spend sitting on a weekday". The time spent sitting include time spent at work, at home, while doing course work, during leisure time, and time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.[25] The IPAQ-SF is validated for assessing SB in the general populace.[26] Regarding SB classification, sitting time ≥ 540 minutes per weekday was considered as cutoff in classifying SB. [26]

Depressive symptoms

The Center for Epidemiologic Studies Depression Scale (CES-D) was used to evaluate the risk of depression among the respondents. This scale contains 20 items evaluating depressive symptoms over the past week and is rated on a 4-point linkert scale of 0 (rarely or none of the time) to 3 (most or all of the time) with scores ranges from 0 to 60.[27] The higher score indicates a greater risk of depression. The scoring of the four positive items in CES-D was reversed. In this study, respondents with CES-D score of 16 or greater was considered as being in risk of depression.[3] Following the four-factor structure elucidated and validated for CES-D, the scale was categorized into 4-subscale of depressive symptoms of positive affect (4 items) (e.g. I was happy, I enjoyed life); somatic symptoms (7 items) (e.g. I could not get going, my sleep was restless); negative affect (7 items) (e.g. I felt fearful, I felt sad); and interpersonal problems (2 items) (people were unfriendly, I felt that people disliked me).[28] The minimum score for each subscale was 0 while the maximum score for somatic symptoms and negative affect, positive affect, and

interpersonal problems was 21, 12 and 6, respectively. Each of the four subscales was treated as continuous variable with higher score indicated higher risk of depressive symptoms. The psychometric properties of CES-D have been established as been appropriate in patients with diabetes.[27]

Covariates

A self-developed proforma was used to obtain the respondents' socio-demographic and clinical information including age, gender, body mass index, diabetes duration, history of alcohol intake and cigarette smoking, employment, marital, education, and income status. Respondents with first degree or higher was categorized as being with high education and those without as low education. Income was categorized as low (< $2 per day), medium ($2-$5 per day) and high (>$5 per day). The level of social support and PA was also evaluated. Social support was assessed by the Multidimensional Scale of Perceived Social Support (MSPSS) while PA of the respondents was assessed by the IPAQ-SF and expressed as being physically active or inactive following international protocols. The scoring of MSPSS and IPAQ-SF has been explained elsewhere.[29-31]

Data analysis

Frequency, percentage, means and standard deviation was used to summarize socio-demographic and clinical data. Chi-square and Mann-Whitney U tests were used to investigate the gender differences in sedentary, depression and different dimensions of depression among the respondents. Multiple linear regression models with bootstrapping of 5000 samples were run to test the association of SB (in minutes) with depression and different dimensions of depressive symptoms (positive affect, negative affect, somatic symptoms and interpersonal problems). Each bootstrap model, conducted separately for the total CES-D scores, positive affect, negative affect, somatic symptoms and interpersonal problems CES-D sub-scale scores, was adjusted for age,

gender, body mass index, diabetes duration, history of alcohol intake and cigarette smoking, perceived social support, physical activity, employment, marital, education, and income status.

In order to investigate the moderating effect of gender on the associations of SB with depression and its dimensions, a simple moderation analysis using PROCESS Macro was performed with total CES-D scores, positive affect, negative affect, somatic symptoms and interpersonal problems CES-D sub-scale scores separately serving as outcome variables. 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.

Results

The mean age was 58.7 ± 10.7 years with majority (61.0 %) being female. About 31.6 % and 17.4 % had medium and high income levels. About half of the respondents were physically active (51.3 %), while 26.2 % and 23.9 % were depressive and sedentary (Table 1). Of all the dimensions of depressive symptoms, majority (41.58 %) of the respondents were presented with somatic symptoms (Figure 1). As shown in Table 2, there were no gender differences in the sedentary behaviour, depression and in any of the different dimensions of depression among the respondents ($p > 0.05$).

After adjusting for age, gender, body mass index, diabetes duration, history of alcohol intake and cigarette smoking, perceived social support, physical activity, employment, marital, education, and income status, the results of multiple linear regression showed that SB (in minutes) was significantly and positively associated with the total CES-D (β: 0.76; (95% Confidence Interval (CI): 0.68-0.83)) and all the dimensions of depression including positive affect (β: 0.50; CI: 0.39-0.61), negative affect (β: 0.54; CI: 0.40-0.69), somatic symptoms (β: 0.79; CI: 0.72-0.87),

and interpersonal problems (β: 0.41; CI: 0.32-0.51). In all the dimensions of depression, somatic symptoms had the strongest association with SB (Table 3).

The results of Moderation analysis revealed that gender moderates the relationship between SB and depression (B = -0.012; 95% CI: -0.016 ~ -0.007; $p < 0.001$). The results showed a higher conditional effect of SB on depression in female than in male respondents (0.036; 95% CI: 0.032-0.039; $p < 0.001$ vs. 0.024; 95% CI: 0.021-0.027 ; $p < 0.001$) (Table 4, Fig. 2). Likewise, gender moderates the relationship between SB and all dimensions of depressive symptoms except in somatic symptoms. The conditional effect of SB on positive affect, negative affect and interpersonal problems were significantly higher in women (Table 4, Figs. 3, 4 and 5).

Discussion

In this study, we examined the associations of SB with depression and different dimensions of depressive symptoms (negative affect, positive affect, somatic symptoms, and interpersonal problems), and investigated if the associations are moderated by gender in adults with diabetes. The findings of this study showed that SB is significantly associated with depression, and distinctly associated with all the different dimensions of depressive symptoms evaluated. Also, gender moderates the association between SB and depression and some dimensions of depressive symptoms (positive affect, negative affect and interpersonal problems).

The significant relationship between SB and depression observed among individuals with diabetes in this study was similar to the results obtained by Indelicato et al.[10] while investigating the sex differences in the association of psychological status with measures of physical activity and sedentary behaviour in adults with type 2 diabetes. It is known that SB is an independent predictor of depression in healthy individuals irrespective of PA levels. Whereas PA may show inconsistent association with depressive symptoms, SB has always found to be associated with

depression.[32, 33] Despite it being considered as a public health concern, little is known on the potential contribution of SB to the depressive symptoms in individuals with diabetes.[5, 10] In this study, SB was significantly associated with depression in adults with diabetes even after adjusted for many known cofounders of depression. Individuals with diabetes are prone to depression which in turn worsens clinical outcomes. More so as this cohort are also prone to unhealthy behaviour e.g. SB which may precipitate or worsen episodes of depression, it has earlier been recommended that the link between depression and SB in diabetic individuals be more elucidated in order to help public health professionals to curb the attendant risks associated with this behaviour.[10] There are few theories linking SB with depression. The major theories postulate that the associated reduction of PA and social support in individuals with increasing SB have direct link with depression. PA participation and socialization are known potent anti-depressant, however, according to these theories, individuals with increasing SB tends to be physically inactive and receive little or no social support networks and therefore the loss of the potential anti-depressant effect of PA and social support.[32, 34, 35]

With respect to the different dimensions of depression, in this study, SB was significantly, positively and distinctly associated with all dimensions of depression including positive affect, negative affect, somatic symptoms and interpersonal problems. Studies had earlier reported non-uniform positive association between different dimensions of depressive symptoms and SB in adolescents[13] and in 11 to 13-year old children,[22] while Elavsky et al.[36] and Okely et al.[37] had identified significant association of SB with positive and negative affect among middle-aged women and older healthy adults indicating a somewhat specific link between SB and different dimensions of depression. In addition, the strongest association was observed between SB and somatic symptoms among all the dimensions of depression investigated in this study. In fact, the

strength of association between SB and somatic symptoms is comparable to that of the association observed between SB and overall depression, i.e. total CES-D in this cohort. These findings suggest that the negative effect of SB on depression was expressed mainly through somatic symptoms more than other symptoms of depression among patients with diabetes. Moreover, the somatic symptoms is the most common depressive symptoms expressed by the respondents as at least 4 out of every 10 individuals with diabetes reported to be suffering from somatic symptoms in this study.

Somatic symptoms, which is recently described in the Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM-5), are presentation of physical symptoms or complaints including excessive emotion, thoughts, and/or related behaviour which may initiate or aggravate enormous distress or dysfunction in individuals.[38] Somatic symptoms have been reported to be related to medical illness sometimes[39] including diabetes illness.[40,41] Few previous studies have reported high prevalence of somatic symptoms among diabetes patients.[41-43] It seems diabetes is a major precursor for developing somatic symptoms as evidence has shown that individuals with diabetes are more prone to somatic symptoms than in the general healthy populace.[41] The recent case-control study of Heidari et al. identified that psycho-fatigue, gastrointestinal, neuro-skeletal, and pharyngeal-respiratory symptoms including headache, severe fatigue, feeling low on energy, joints pain, dry mouth, sleep disorder and shortness of breath as some of the commonest somatic symptoms associated with individuals with diabetes.[41] In addition to many factors associated with somatic symptoms among diabetes population in the literature, the findings of this study suggest that SB may be a potential contributor to the high prevalence of somatic symptoms seen in this cohort. Although it seems some of the aforementioned somatic symptoms are associated with SB in other clinical population, it is imperative to investigate the link, biological or otherwise, between

SB and somatic symptoms in adults with diabetes. Furthermore, strategies in reducing or breaking SB, in conjunction with other known effective strategies, should be looked into in tackling the problem of somatization in diabetes. Provision of mitigating strategies to SB is essential since somatic symptoms are known to be debilitating to individuals with diabetes and worsen the clinical outcomes of diabetes;[41] and literature has affirmed that patients with somatization incur twice the inpatient and outpatient medical care utilization, and twice the annual healthcare cost when compared with non-somatizing patients.[44]

Similar to the previous findings among diabetes patients,[10] gender significantly moderated the relationship between SB and depression as we observed differential patterns of association of SB and depression between men and women in this study. However, contrary to the reports of Indelicato et al. wherein relationship between SB and depression was significant only among women with diabetes,[10] our study demonstrated that effect of SB on depression was significant in both gender but was more significantly pronounced among women than men. The discrepancy between the two findings may be attributed to the difference in sample size, methodology and statistical analysis approach. Moreover, the findings of Indelicato et al.[10] and this study revealed that adult women with diabetes are more prone to depression through SB than men. Similarly, the effect of SB on all dimensions of depressive symptoms was more pronounced among women than men except in somatic symptoms. This indicates that sedentary adult women with diabetes displayed more significant association between SB and depressive symptoms of positive affect, negative affect and interpersonal problems than men. The findings was similar to earlier reports showing that the association between SB and negative affect was moderated by gender in the reports of Zink et al.[13] Zink and colleagues reported that adolescent girls showed significant association between SB and negative affect depressive symptoms and not in boys.[13] There seems

a discrepancy in the gender difference in SB prevalence in adults with diabetes. It has been earlier reported that women with diabetes spent less time being sedentary than men,[10] while the findings of our previous study[45] and this study showed no gender differences in the prevalence of SB. It must be stated however that women have been found to be more expressive of their emotions and more ruminating than men,[46, 47] which might explain the higher impact of SB on depression and its dimensions found in women in this study. Since the underlying mechanisms responsible for differential patterns of association between SB and depression in terms of gender is not yet understood in diabetes,[10] these findings suggest that further research identifying the gender-related link between SB and depression and different dimensions of depression among adults with diabetes may be warranted. Also, specific intervention programmes for depression and its dimensions may need to be developed for men and women with diabetes.

There are few potential limitations to the findings of this study. First, as we utilized relatively homogenous sample from one hospital setting, thus limiting generalizability of the findings to other non-similar contexts. Second, the use of self-reported measures for SB and depressive symptoms may introduce reporting bias and underestimation of the observed associations. This phenomenon is plausible as the use of questionnaire tend to underestimate SB,[48] and more so, anecdotal and previous reports have opined that people in the study environment tend to deny or denigrate issues regarding their psychosocial health, especially during research and clinical assessments.[49] In addition, the prevalence of depression and different dimensions of depression obtained in this study is limited to CES-D which cannot be taken as detailed psychiatric assessment necessary for the clinical diagnosis of depression and its different forms. Lastly, the cross-sectional nature of the study precludes us from making causal and directional conclusions on the associations of SB with depression and different dimensions of depressive symptoms. Thus,

longitudinal studies with the use of objective measure of SB and depressive symptoms from multiple settings are warranted.

Conclusion

Our findings suggest that the association of SB with depression and different dimensions of depressive symptoms was unique and non-uniform, and was moderated by gender in adults with diabetes. Overall, the impact of SB on depression was more likely to be expressed as somatic symptoms than any other dimension of depression in diabetes patients. Furthermore, the impact of SB on depression, positive affect, negative affect and interpersonal problems was observed mostly among women with diabetes. Gender-specific strategies to reduce or break SB among diabetes patients should be formulated to lessen the apparent negative impact of SB on depression and its dimensions.

References

1. van Dooren, F.E., Nefs, G., Schram, M.T., Verhey, F.R., Denollet, J., Pouwer, F. Depression and risk of mortality in people with diabetes mellitus: a systematic review and meta-analysis. PloS One. 2013; 8 (3): e57058.
2. Alosaimi, F.D., Labani, R., Almasoud, N., Alhelali, N., Althawadi, L., AlJahani, D.M. Associations of foot ulceration with quality of life and psychosocial determinants among patients with diabetes; a case-control study. J. Foot Ankle Res. 2019; 12 (1): 57.
3. Lina Darwish, Erika Beroncal, Ma Veronica Sison, Walter Swardfager. Depression in people with type 2 diabetes: current perspectives. Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy. 2018; 11:333–343.
4. Joseph Henson, David W. Dunstan, Melanie J. Davies, Thomas Yates. Sedentary behaviour as a new behavioural target in the prevention and treatment of type 2 diabetes. Diabetes Metab Res Rev 2016; 32(Suppl. 1): 213–220.
5. Hidde P. van der Ploeg and Melvyn Hillsdon. Is sedentary behaviour just physical inactivity by another name? Int J Behav Nutr and Phys Act, 2017; 14:142.
6. Matthews CE, Chen KY, Freedson PS, Buchowski MS, Beech BM, Pate RR et al. Amount of time spent in sedentary behaviors in the United States, 2003- 2004. Am J Epidemiol. 2008; 167(7): 875–881.
7. Hayward J, Jacka FN, Skouteris H, Millar L, Strugnell C, Swinburn BA, Allender S. Lifestyle factors and adolescent depressive symptomatology: Associations and effect sizes of diet, physical activity and sedentary behaviour. Aust N Z J Psychiatry. 2016; 50(11):1064-1073.
8. Raudsepp L. Brief report: Longitudinal associations between sedentary behaviours and depressive symptoms in adolescent girls. J Adolesc. 2016; 51:76–80.

9. David W. Dunstan and Neville Owen. Less Sitting for Preventing Type 2 Diabetes. Diabetes Care, 2021; 44:2194–2196.
10. Liliana Indelicato, Marco Dauriz, Elisabetta Bacchi, Silvia Donà, Lorenza Santi, Carlo Negri et al. Sex differences in the association of psychological status with measures of physical activity and sedentary behaviour in adults with type 2 diabetes. Acta Diabetol. 2018; 55(6):627-635.
11. Hankin BL. Adolescent depression: Description, causes, and interventions. Epilepsy & Behavior. 2006; 8:102–114.
12. Hasler G, Drevets WC, Manji HK, Charney DS. Discovering endophenotypes for major depression. Neuropsychopharmacology: official publication of the American College of Neuropsychopharmacology. 2004; 29:1765–1781.
13. Jennifer Zink, Shayan Ebrahimian, Britni R. Belcher, Adam M. Leventhal. Reciprocal associations between depression and screen-based sedentary behaviors in adolescents differ by depressive symptom dimension and screen-type. J Affect Disord. 2020; 263:39–46.
14. Brendon Stubbs, Davy Vancampfort, Joseph Firth, Felipe B. Schuch, Mats Hallgren, Lee Smith et al. Relationship between sedentary behavior and depression: a mediation analysis of influential factors across the lifespan among 42,469 people in low- and middle-income c o u n t r i e s. J Affect Disord. 2018; 15(229):231-238.
15. Bélair M-A, Kohen DE, Kingsbury M, Colman I. Relationship between leisure time physical activity, sedentary behaviour and symptoms of depression and anxiety: evidence from a population based sample of Canadian adolescents. BMJ Open. 2018; 8(10):e021119.

16. Yuchai Huang, Liqing Li, Yong Gan, Chao Wang, Heng Jiang, Shiyi Cao et al. Sedentary behaviors and risk of depression: a meta-analysis of prospective studies. Transl Psychiatry. 2020; 10:26.
17. Aaron Kandola, Gemma Lewis, David P J Osborn, Brendon Stubbs, Joseph F Hayes. Depressive symptoms and objectively measured physical activity and sedentary behaviour throughout adolescence: a prospective cohort study. Lancet Psychiatry, 2020; 7: 262–71.
18. Morres, I. D.,Touloudi, E., Hatzigeorgiadis, A., Jamurtas, A. Z., Androutsos, O., & Theodorakis, Y. Daily Life Physical Activity, Quality of Life and Symptoms of Depression and Anxiety in Adult Patients with Type 2 Diabetes: A Preliminary Study. Psychology, 2021; 12:1277-1286.
19. Van Dam NT, Earleywine M. Validation of the Center for Epidemiologic Studies Depression Scale—Revised (CESD-R): Pragmatic depression assessment in the general population. Psychiatry Research. 2011; 186:128–132.
20. Leventhal AM, Ramsey SE, Brown RA, LaChance HR, Kahler CW. Dimensions of depressive symptoms and smoking cessation. Nicotine Tob Res. 2008; 10(3):507–517.
21. Gotlib, I.H., & Hammen, C.L. Introduction. In I.H. Gotlib & C.L. Hammen (Eds.), Handbook of depression (pp. 1-20). New York: Guilford Press. 2002.
22. Anton SD, Newton RL Jr., Sothern M, Martin CK, Stewart TM, Williamson DA. Association of depression with Body Mass Index, sedentary behavior, and maladaptive eating attitudes and behaviors in 11 to 13-year old children. Eating and Weight disorders: EWD, 2006; 11:e102–108.
23. Kasiulevicius V, Sapoka V, Filipaviciute R. Sample size calculation in epidemiological studies. Gerontologija. 2006; 7(4): 225-231.

24. HT Ilori, AT Salawu and OI Fawole. Depression and anxiety among patients with type 2 diabetes mellitus in Ibadan, Oyo State. Afr. J. Med. Med. Sci. 2021; 50:189-197.
25. International Physical Activity Questionnaire. Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire (IPAQ)–Short Form. Version 2.0. 2004. Available: http://www.institutferran.org/documentos/Scoring_short_ipaq.
26. 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.
27. van Dijk SEM, Adriaanse MC, van der Zwaan L, Bosmans JE, van Marwijk H, van Tulder MW, Terwee CB. Measurement properties of depression questionnaires in patients with diabetes: a systematic review. Qual Life Res. 2018; 27(6):1415–1430.
28. Ha T. Nguyen, Melissa Kitner-Triolo, Michele K. Evans, Alan B. Zonderman. Factorial invariance of the CES-D in low socioeconomic status African Americans comparedwith a nationally representative sample. Psychiatry Research. 2004; 126: 177–187.
29. Dahlem N, Zimet G, Walker R. The multidimensional scale of perceived social support: a confirmation study. J Clin Psychol. 1991; 47(6):756-61.
30. Maddalena De Maria, Ercole Vellone, Angela Durante, Valentina Biagioli, Maria Matarese. Psychometrics evaluation of the multidimensional scale of perceived social support (MSPSS) in people with chronic disease. Ann 1st Super Sanita. 2018; 54(4):308-315.

31. Chiang, C. C., Chiou, S. T., Liao, Y. M., &Liou, Y. M. The perceived neighborhood environment is associated with health-enhancing physical activity among adults: a cross-sectional survey of 13 townships in Taiwan. BMC Public Health, 2019; 19:524.
32. Teychenne M, Ball K, Salmon J. Sedentary behavior and depression among adults: a review. Int J Behav Med. 2010; 17(4):246–254.
33. Breland JY, Fox AM, Horowitz CR. Screen time, physical activity and depression risk in minority women. Ment Health Phys Act. 2013; 6(1):10–15.
34. Biddle SJ, Asare M. Physical activity and mental health in children and adolescents: a review of reviews. Br J Sports Med, 2011; 45(11):886–95.
35. Zhai L, Zhang Y, Zhang D. Sedentary behaviour and the risk of depression: a meta-analysis. Br J Sports Med. 2015; 49(11):705-9.
36. Steriani Elavsky, Moé Kishida, and Jacqueline A. Mogle. Concurrent and Lagged Relations between Momentary Affect and Sedentary Behavior in Middle-Aged Women. Menopause. 2016; 23(8): 919–923.
37. Udith A. Okely , Iva Čukić, Richard J. Shaw, Sebastien F. Chastin, Philippa M. Dall, Ian J. Deary et al. Gale and on behalf of the Seniors USP team. Positive and negative well-being and objectively measured sedentary behaviour in older adults: evidence from three cohorts. BMC Geriatrics. 2019; 19:28.
38. Kurlansik SL, Maffei MS. Somatic Symptoms Disorder. Am Fam Physician. 2016; 93(1):49-54.
39. D'Souza RS, Hooten WM. Somatic Syndrome Disorder. [Updated 2022 May 2]. In: Stat Pearls [Internet]. Treasure Island (FL): Stat Pearls Publishing; 2022 Jan.

40. Wei-Chih Hsu, Amy Ming-Fang Yen, Horng-Huei Liou, Han-Cheng Wang, Tony Hsiu-His Chen. Prevalence and Risk Factors of Somatic and Autonomic Neuropathy in Prediabetic and Diabetic Patients. Neuroepidemiology. 2009; 33:344–349.
41. Zahra Heidari, Awat Feizi1, Ammar Hassanzadeh Keshteli, Hamid Afshar, Hamidreza Roohafza and Peyman Adib. Psychosomatic complaints profile in patients with type 2 diabetes: a matched case-control study. The Egyptian Journal of Neurology, Psychiatry and Neurosurgery. 2019; 55:53.
42. Aikens JE. Prevalence of somatic indicators of distress in diabetes patients: comparison to psychiatric patients and community nonpatients. Int J Psychiatry Med. 1998; 28(3):265–72.
43. Baumert J, Meisinger C, Lukaschek K, Emeny RT, Rückert IM, Kruse J, et al. A pattern of unspecific somatic symptoms as long-term premonitory signs of type 2 diabetes: findings from the population-based MONICA/ KORA cohort study, 1984-2009. BMC Endocr Disord. 2014; 14:1–9.
44. Arthur J. Barsky, E. John Orav, David W. Bates. Somatization Increases Medical Utilization and Costs Independent of Psychiatric and Medical Comorbidity. Arch Gen Psychiatry. 2005; 62:903-910.
45. Ademoyegun, A.B., Afolabi, O.E., Aghedo, I.A., Adelowokan O.I., Mbada C.E., Awotidebe, T.O. The Mediating Role of Sedentary Behaviour in the Relationship Between Social Support and Depression Among Individuals with Diabetes. Mediterranean Journal of Clinical Psychology, 2022; 10(2).
46. Nolen-Hoeksema S, Jackson B. Mediators of the gender difference in rumination. Psychology of Women. 2001; 25:37–47.

47. McCullough ME, Orsulak P, Brandon A, Akers L. Rumination, fear, and cortisol: An in vivo study of interpersonal transgressions. Health Psychology. 2007; 26(1):126–132.
48. Copeland JL, Ashe MC, Biddle SJ, Brown WJ, Buman MP, Chastin S, et al. Sedentary time in older adults: a critical review of measurement, associations with health, and interventions. Br J Sports Med. 2017; 51:1539.
49. Chidozie Emmanuel Mbada, Olaniyi Onayemi, Yewande Ogunmoyole, Olubusola Esther Johnson, and Christopher O. Akosile. Health-related quality of life and physical functioning in people living with HIV/AIDS: a case-control design. Health Qual Life Outcomes. 2013; 11:106.

Conflict of interest

None

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Author 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. All authors read and approved the final version of the manuscript.

Acknowledgements

The authors appreciate the support of patients and staff in the Endocrinology Unit, Department of Internal Medicine, Osun State University Teaching Hospital, Osogbo, Nigeria.

Table 1: General characteristics of the respondents (N = 351)

Variable	N (%) or Mean ± SD
Female	214 (61.0)
Age (years)	58.7 ± 10.7
Age group (≤ 64 years)	250 (71.2)
Marital status (Married)	297 (84.6)
BMI	27.0 ± 3.75
Employent status (Employed)	181 (51.6)
Education status (Low)	207 (59.0)
Income level (Low)	179 (51.0)
Duration (≤ 10 years)	245 (69.8)
Positive history of smoking (No)	334 (95.2)
Positive history of alcohol intake (No)	333 (94.9)
PA (Active)	180 (51.3)
MSPSS	65.7 ± 13.4
Sedentary behaviour (No)	267 (76.1)
Depressive status (No)	259 (73.8)
Total CES-D	10.6 ± 9.2
CES-D Positive affect	2.76 ± 3.0
CES-D Negative affect	2.65 ± 2.64
CES-D Somatic symptoms	4.40 ± 4.54
CES-D Interpersonal problems	0.76 ± 1.05

Key: BMI, body mass index; PA, physical activity; MSPSS, multidimensional scale of perceived social support; CES-D, center for epidemiologic studies depression scale.

Table 2: Gender differences in sedentary behaviour, depression and different dimensions of depression (N = 351)

Variable	Female	Male	P-value
Sedentary behaviour [a] (Yes)	48 (13.7)	36 (10.3)	0.410
Sedentary behaviour[b] (minutes)	170.38	184.78	0.194
Depressive status [a] (Yes)	53 (15.1)	39 (11.1)	0.442
Total CES-D[b]	178.31	172.39	0.593
CES-D Positive affect[b]	182.31	166.15	0.138
CES-D Negative affect[b]	183.26	164.65	0.089
CES-D Somatic symptoms	172.23	181.89	0.380
CES-D Interpersonal problems[b]	177.28	174.00	0.745

Key: [a] chi square test expressed in number and (percentage); [b] Mann-Whitney U test expressed in mean rank; CES-D center for epidemiologic studies depression scale.

Table 3: Relationship of sedentary behaviour with depression and different dimensions of depressive symptoms

Variable	β (95% CI)[a, b]	P-value
Total CES-D	0.76 (0.68-0.83)	<0.001
Positive affect	0.50 (0.39-0.61)	<0.001
Negative affect	0.54 (0.40-0.69)	<0.001
Somatic symptoms	0.79 (0.72-0.87)	<0.001
Interpersonal problems	0.41 (0.32-0.51)	<0.001

Key: CI, Confidence interval; CES-D, center for epidemiologic studies depression scale; [a] adjusted for age, gender, body mass index, diabetes duration, history of alcohol intake and cigarette smoking, perceived social support, physical activity, employment, marital, education, and income status;

[b] bootstrap values .

Table 4: The moderating effect of gender on the association of sedentary behaviour with depression and different dimensions of depressive symptoms

	coefficient	se	t	p-value	95%CI	conditional effects of sedentary behaviour by gender				
							effect	se	t	p	95% CI
Total CES-D[a]						F	0.036	0.002	21.859	<0.001	0.032-0.039
SB (minutes)	0.036	0.002	21.859	<0.001	0.032-0.039	M	0.024	0.002	14.705	<0.001	0.021-0.027
Gender	-2.218	0.587	-3.780	<0.001	-3.372 ~ -1.064						
Interaction	-0.012	0.002	-5.036	<0.001	-0.016 ~ -0.007						
	R^2 = 66.7%; Change in R^2 = 2.4%										
Positive Affect[a]						F	0.010	0.001	13.368	<0.001	0.009-0.011
SB (minutes)	0.010	0.001	13.368	<0.001	0.009-0.011	M	0.002	0.001	2.445	0.015	0.000-0.003
Gender	-1.236	0.270	-4.579	<0.001	-1.767 ~ -0.705						
Interaction	-0.008	0.001	-7.715	<0.001	-0.010 ~ -0.006						
	R^2 = 36.4%; Change in R^2 = 10.9%										
Negative Affect[a]						F	0.008	0.001	12.628	<0.001	0.007-0.009
SB (minutes)	0.008	0.001	12.628	<0.001	0.007-0.009	M	0.005	0.001	8.571	<0.001	0.004-0.007
Gender	-0.769	0.226	-3.406	0.001	-1.213 ~ -0.325						
Interaction	-0.003	0.001	-2.856	0.005	-0.004 ~ -0.001						
	R^2 = 40.6%; Change in R^2 = 1.4%										
Somatic Symptoms[a]											
SB (minutes)	0.014	0.001	18.621	<0.001	0.013-0.016						
Gender	0.109	0.277	0.395	0.693	-0.436~ 0.655						
Interaction	0.002	0.001	1.493	0.136	-0.001~ 0.004						
	R^2 = 69.3%; Change in R^2 = 0.2%										
Interpersonal Problems[a]						F	0.003	0.000	12.445	<0.001	0.003-0.004
SB (minutes)	0.003	0.000	12.445	<0.001	0.003-0.004	M	0.001	0.000	2.936	0.004	0.000-0.001
Gender	-0.281	0.096	-2.942	0.003	-0.469 ~ -0.093						
Interaction	-0.003	0.000	-6.714	<0.001	-0.003 ~ -0.002						
	R^2 = 32.6%; Change in R^2 = 8.8%										

CES-D center for epidemiologic studies depression scale; [a] outcome variable; se standard error; CI confidence interval; SB sedentary behaviour.