Vol. 20(1), pp. 23-32, July-December 2021
DOI: 10.5897/JNSP2021.0012
Article Number: 6823C1467680
ISSN 0331-3735

http://www.academicjournals.org/JNSP

ACADEMIC JOURNALS
expand your knowledge

Journal of the Nigeria Society of Physiotherapy

Official publication of the Nigeria Society of Physiotherapy

Full Length Research Paper

Pattern of physical activity, sleep duration and quality of life among individuals with diabetes mellitus in selected health facilities in Kano, Northwestern Nigeria

Jibril Mohammed Nuhu[1*], Umar Hadi Tijjani[1], Umaru Muhammad Badaru[1], Abdulsalam Mohammed Yakasai[2] and Musa Sani Danazumi[1]

[1]Department of Physiotherapy, Bayero University, Kano, Nigeria.
[2]Medical Rehabilitation Therapist Board of Nigeria, Kano Zonal Office, Kano, Nigeria.

Received 5 May, 2021; Accepted 25 August, 2021

Data on physical activity (PA) and sleep duration (SD) as important correlates of quality of life (QoL) among diabetic patients are scarce. This study investigated the pattern of self-reported PA, SD and QoL in purposively selected diabetes patients (N = 124, mean age: 54.61) at two major hospitals in Kano, Nigeria. Respondents' PA level, SD and QoL were estimated using the International PA Questionnaire, a single-item measure of sleep and the Short Form-36 Health Survey respectively. Nighttime SD was estimated in hours and the mean for the previous seven days was recorded. Respondents' socio-demographic characteristics were also obtained while weight and height were measured. Data were analysed using descriptive and inferential statistics (Spearman correlation) at p ≤0.05. 56.5%, 37.9% and 5.6% of them had low, moderate and high PA levels respectively. 57 (46%) slept for <6 hours and 67 (54%) for 6-8 hours. While 86% had QoL physical component summary of <50, 13% had ≥50. Those with mental component summary <50 (57.3%) were also more than those with values ≥50 (42.7%). There was no significant correlation between PA and either of the two clinical variables (sleep duration [p = 0.075, r = 0.160] and QoL [SF-36 PSC, p = 0.435, r = 0.071; SF-36 MSC, p = 0.379, r = -0.080]). Furthermore, SD did not significantly correlate with QoL (p > 0.05). In conclusion, the majority of the respondents were not meeting any of the criteria for either moderate or high levels of PA with SD being poor for significant proportion of them for optimal QoL and general wellbeing.

Key words: Physical activity; Sleep duration; Quality of life; Diabetes mellitus; Northwestern Nigeria.

INTRODUCTION

Diabetes mellitus (DM) is a syndrome characterized by chronic hyperglycemia due to deficient production of insulin or ineffectiveness in its utilization by the cells, leading to abnormally high levels of glucose in circulation (International Diabetes Federation, 2019). It is the most common metabolic disease and has been recognized as a clinical syndrome since ancient times (Marianna et al., 2016). The development of the disorder is linked to the

*Corresponding author. E-mail: jibrilnuhu701@gmail.com.

interaction between inherited and acquired factors notably the frequent consumption of easily accessible highly processed energy-dense fast food and persistent physical inactivity (Adeghate et al., 2006).

Currently, diabetes is identified as ubiquitous and crippling (Kumar et al., 2013) and the number of individuals with the disorder is increasing at an alarming rate. In Africa, the number is expected to increase from 19 million cases in 2020 to 47 million by 2045 with Nigeria, the most populous country in the continent, accounting for almost three million adult cases (International Diabetes Federation, 2021). As is the case with other parts of the world, Nigeria is likely to continue to experience an increase in the number of individuals with the disease, which will escalate the already existing burden.

In addition to the associated symptoms of the disease (frequent urination, increased thirst and increased hunger) (World Health Organization, 2013) which can overwhelm patients, serious long-term complications comprising stroke, coronary heart disease, chronic kidney disease, damage to the eyes and foot ulceration causing further suffering (World Health Organization, 2013). Diabetes can also negatively impact a wide range of key human physiological processes including sleep, energy conservation and immune function (Beccuti and Pannain, 2011; Grandner et al., 2011; Zizi et al., 2010). These important physiological processes, in particular sleep, appear to have a bi-directional relationship with the occurrence of diabetes. As an essential biological function, sleep is a critical determinant of overall health and survival (Rechtschaffen et al., 1989). Optimal levels of sleep have been shown to positively impact memory, learning, emotion, removal of toxin at cellular level and cardiometabolic function (Cincin et al., 2015; Davies et al., 2014; Frank et al., 2013; Xie et al., 2013). Concerns are mounting with respect to inadequate sleep (a significant part of modern lifestyle) contributing to the development of diabetes (Cappuccio et al., 2010; Kawakami et al., 2004; Öztürk et al., 2015). On the other hand, individuals with diabetes have reported a reduction in sleep quality, increased frequency of insomnia, excessive daytime sleepiness and higher sleep medication use (Skomro et al., 2001). Frequently, the precursors of sleep disturbances in diabetes are complications such as peripheral neuropathy, pain and polyuria, obstructive sleep apnea, restless leg syndrome and nocturnal hypoglycaemia (Surani, 2015), and these have been related to a heightened risk of cardiovascular complications with increased risk of death (Ayas et al., 2003). Thus, chronic sleep of short duration or low quality, known as poor sleep, is associated with compromise in both physical and mental health and can impact an individual's ability to perform physical activity (PA) which is a significant adjunct in diabetes management.

Physical activity is defined as any movement (such as walking, running, dancing, biking, performing household chores, swimming, exercising, and engaging in sports activities) that uses skeletal muscles and requires more energy than resting (Caspersen et al., 1985). PA can improve sleep quality (Dolezal et al., 2017; Wang and Boros, 2019), while sleep restriction may negatively impact physical activity (Bromley et al., 2012) both of which may adversely affect quality of life.

Quality of life (QoL) is a significant multi-component concept that includes physical and socio-emotional aspects of an individual's life. It is routinely used in research as a primary endpoint to indicate health status and monitor the impact of interventions in various chronic diseases including diabetes (Maharaj and Nuhu, 2015). Decreased quality of life adversely impacts not only the happiness and satisfaction of persons with DM, but also their engagement in socio-economic activities and compliance to treatment (Snel et al., 2012). Research evidence has proven that QoL for patients with DM is lower than that of their non-diabetic counterparts and that increases in levels of PA can help to offset this (Çolak et al., 2015; Maharaj and Nuhu, 2015). Factors such as advanced age, use of insulin, diabetes complications, inadequate sleep, psychosocial factors and so forth may interfere in the QoL for persons with diabetes (Kiadaliri et al., 2013). QoL is also known to be related to physical activity and individuals with diabetes who are physically active tend to have higher QoL scores than those that are inactive (Maharaj and Nuhu, 2015; Çolak et al., 2015).

Little information is documented on PA levels in persons with DM in developing countries. While Adeniyi et al. (2010) found that patients with diabetes were more physically active at moderate levels, Oguntibeju et al. (2012) indicated that a large proportion of these individuals had a low PA level. Significant positive relationship has been shown between PA levels and QoL of individuals with diabetes (Çolak et al., 2015) indicating that PA has a positive impact on QoL. A third study also found that the majority of the participants (with diabetes) had low PA levels (54.7%) (Shiriyedeve et al., 2019).

There is a need for data to be provided about the pattern of physical activity, sleep duration and health-related quality of life among persons with diabetes given the dearth of such information particularly in resource-poor settings. Specifically, the assessment of sleep disorders is important in persons with DM (American Diabetes Association, 2018) as sleep anomaly acting alone or in conjunction with any of the other complications and co-morbidities can severely interfere with physical and psychosocial well-being thereby compromising overall quality of life. Information obtained from this study can serve to stimulate stakeholders in diabetes management to make recommendations and, possibly, create or modify approaches to enhance quality of care as it pertains to non-pharmacological management of diabetes. This study was, thus, undertaken to explore the pattern of physical activity, self-reported sleep and quality of life among individuals with diabetes mellitus in the two major Kano State-owned health facilities in Kano, Northwestern Nigeria.

METHODOLOGY

Study setting and design

A cross sectional survey was used to gather information from persons with diabetes mellitus attending diabetes clinics for follow up at Murtala Muhammad Specialist Hospital (bed capacity of 826) and Muhammad Abdullahi Wase Teaching Hospital (320-bedded) in Kano, Northwestern Nigeria. These are two large referral secondary health facilities (located in the metropolis) owned by the Kano State Government which serve the people of Kano State including those from neighboring states (Hadiza, 2018). Convenience sampling technique was used to recruit the participants who were approached and recruited at the diabetes clinics of the two hospitals.

Data collection procedure

Prior to the commencement of the survey, ethical approval was sought and obtained from the Research Ethics Committee of Kano State Ministry of Health. Potential respondents were approached and the purpose and importance of the study was clearly explained. They were also informed that participation in the survey was voluntary and that they were at liberty to withdraw their consent/participation at any time or decline from filling in the questionnaires. The study was conducted between July 2019 and January 2020 and data were collected at the diabetes clinic of the two hospitals.

All questionnaires were translated from English to Hausa by a qualified translator for the purpose of our study. This was to maintain consistency and stability with interviewer administration of the questionnaires in the target language for those not familiar with English. Questionnaires were either self- or interviewer-administered. Interview was conducted by the researchers and trained interviewers. Majority of the participants (n = 76) self-completed the survey.

Assessment of physical activity level

Respondents' physical activity (PA) levels were assessed using the short form International Physical Activity Questionnaire (IPAQ-SF). Due to its ease of completion relative to the long form, the IPAQ-SF is recommended for surveys where time is limited (Craig et al., 2003). The types of intensity of PA and sitting time accrued by individuals as part of their daily lives are considered for estimating total PA and time spent sitting. The instrument consists of seven items and measures the level of PA (expressed in MET-minutes/week [www.ipaq.ki.se]) across four domains (leisure time PA, domestic and gardening activities, work-related PA, and transport-related PA). In each domain, the duration (in minutes) and frequency (days) of PA including sitting, walking, moderate and vigorous PA are self-reported (Lee et al., 2011).

The IPAQ was shown to be reliable (p = 0.76) and at least as valid as other physical-activity measures (concurrent = 0.58; criterion = 0.30 against the Computer Science Accelerometer) (Craig et al., 2003). It has also been shown to be reliable and valid in obtaining comparable estimates of PA, based on activity undertaken across multiple domains including leisure, domestic, work and transport (Hagströmer et al., 2006). The Hausa IPAQ-SF has acceptable concurrent validity and test-retest reliability for vigorous-intensity activity, walking, sitting and total PA, but demonstrated only fair construct validity for moderate and sitting activities. The Hausa IPAQ-SF can be used for physical activity measurements in Nigeria, but further construct validity testing with objective measures such as an accelerometer is needed (Oyeyemi et al., 2011). To determine levels of PA, the following values are used:

Walking MET = 3.3 × walking minutes × walking days;
Moderate MET = 4.0 × walking minutes × walking days;
Vigorous MET = 8.0 × walking minutes × walking days and
Total Physical Activity MET = sum of Walking + Moderate + Vigorous MET minutes/week scores (www.ipaq.ki.se).

Respondents were asked to report on their PA during a typical week. Specifically, they were asked to report the number of days and duration they were engaged in vigorous, moderate, walking activity, and total PA. They were classified into low, moderate and high PA based on their weekly energy expenditure in accordance with the IPAQ scoring protocol on physical activity categories and cut-off levels (Appendix).

Measurement of quality of life

The short-form SF-36 health questionnaire was used to assess the quality of life (QoL) of the respondents. This is an eight-domain generic health-related QoL measure whose validity and reliability have been shown as an assessment tool used to indicate changes in health status (McDowell, 2009) in a wide range of diseased conditions. The domains or subscales which include Mental Health, Role Emotional, Social Functioning, Vitality, General Health, Bodily Pain [BP], Role Physical and Physical Functioning are used collectively to reflect QoL scores (Klevsgård et al., 2002; McDowell, 2009). Scores range from 0 to 100 (expressed as percentages) with higher scores indicating better health (Maruish et al., 2011). For ease of interpretation, a norm-based scoring, with a mean of 50 and a standard deviation of 10 in the general population, is employed. Two component summary scores (the Physical Component Summary [PCS] and the Mental Component Summary [MCS]) are frequently used and are derived when scores from the domains are summed up (Ware and Ware, 1993). The instrument's reliability (median reliability coefficient 0.85 for all subscales) been established (McHorney et al., 1994), and its validity was shown in an elderly population, in which it distinguished between those with and without poor health (Lyons et al., 1994). Although no Hausa translated version of the SF-36 health survey has been documented, the shorter version (SF-12) was demonstrated to have satisfactory construct validity, internal consistency, and test-retest reliability in Hausa-speaking patients with chronic LBP (Ibrahim et al., 2020).

Measurement of sleep duration

Information on respondents' sleep duration (that is, total amount of sleep experienced during the nocturnal sleep episode), was obtained via a single item measure by asking the question "How many hours of sleep did you experience last night?"). Single-item measures are considered reasonable when the construct is concrete and well defined (Konstabel et al., 2017). In addition, they are less expensive to administer and analyse. Although multiple-item measures are preferable from a clinimetric standpoint, a single-item measure could be useful as long as it discriminates between different groups of patients and reflects clinically relevant changes over time (Fava et al., 2012). Respondents reported daily when they slept the previous night and the time they woke up in the morning (Buysse et al., 1989). This nighttime sleep duration was calculated in hours and the mean for the past seven days recorded.

In a study by St-Onge et al. (2016) on sleep duration and quality in cardiometabolic health, inadequate (or short) sleep duration was defined as <7 h per night, and long sleep was described as ≥9 h per night (St-Onge et al., 2016).

Measurement of weight and height

Body weight was measured (at 0.1 kg precision) with a weighing scale (Tanita BWB-800, Arlington Heights, IL), and height (at 0.5 cm scale precision) using a Holtain Harpenden portable stadiometer (Holtain Ltd., Crymych Pembs, UK). These measurements were taken in light clothing without footwear according to standardized protocols (Stewart et al., 2011). Body mass index (BMI) was calculated as weight (kg)/height2 (m2) (Janssen et al., 2002) and was based on standard BMI categories established by the National Heart, Lung, and Blood Institute (1998) as underweight, <18.5; normal weight, 18.5-24.9; overweight, 25.0-29.9, grade 1 obesity, 30.0-34.9, grade 2 obesity, 35.0-39.9, and grade 3 obesity, ≥40.0.

Information about respondents' age, gender, and duration since diagnosis of diabetes was obtained by way of interviewing the respondents and confirmed using their case notes.

Data analysis

Data were analyzed using descriptive (frequency, mean and percentage) and inferential (Spearman correlation) statistics using the Statistical Package for the Social Sciences version 20 (SPSS Inc, Chicago, Illinois, USA). A probability level of ≤0.05 was considered significant.

Measurement of weight and height

Body weight was measured (at 0.1 kg precision) with a weighing scale (Tanita BWB-800, Arlington Heights, IL), and height (at 0.5 cm scale precision) using a Holtain Harpenden portable stadiometer (Holtain Ltd., Crymych Pembs, UK). These measurements were taken in light clothing without footwear according to standardized protocols (Stewart et al., 2011). Body mass index (BMI) was calculated as weight (kg)/height^2 (m^2) (Janssen et al., 2002) and was based on standard BMI categories established by the National Heart, Lung, and Blood Institute (1998) as underweight, <18.5; normal weight, 18.5-24.9; overweight, 25.0-29.9, grade 1 obesity, 30.0-34.9, grade 2 obesity, 35.0-39.9, and grade 3 obesity, ≥40.0.

Information about respondents' age, gender, and duration since diagnosis of diabetes was obtained by way of interviewing the respondents and confirmed using their case notes.

Data analysis

Data were analyzed using descriptive (frequency, mean and percentage) and inferential (Spearman correlation) statistics using the Statistical Package for the Social Sciences version 20 (SPSS Inc, Chicago, Illinois, USA). A probability level of ≤0.05 was considered significant.

RESULTS

Socio-demographic characteristics of the respondents

A total of 124 individuals (76 female and 48 male) diagnosed with diabetes mellitus took part in the study. With a mean age of 54.61, majority of the respondents were within the 40 to 60 years age category and had duration since diagnosis of diabetes of less than 10 years (Table 1). There were more respondents with scores indicating lower than average quality of life in physical component of the SF-36 health survey than those with scores ≥50. This is the case about scores for the mental component of the survey (Table 1). About 60% of them had normal body mass index (Table 1) and over half of them were in the low physical activity category (Figure 1). About half of the respondents reported that they experienced 6 to 8 h per day. However, a greater number (one-third) of them felt that their sleep was adequate (Figure 2).

Correlation between physical activity and clinical variables

No statistically significant correlation was found between physical activity and either of the two clinical variables (sleep duration and QoL). In addition, sleep duration did not significantly correlate with respondents' quality of life (Table 2).

DISCUSSION

This study was carried out to determine the pattern of physical activity, sleep duration and quality of life of individuals with diabetes. The findings of this study show that the majority of the individuals with diabetes had low levels of PA. This supports the results of Thiel et al. (2017) who reported that the majority of the participants did not meet the guidelines for PA with a significant positive association observed between PA and QoL among those with higher levels of PA. The results are also in line with those of a study by Oguntibeju et al. (2012) in which it was shown that a large proportion of the individuals with DM had low PA levels. On the other hand, Adeniyi et al. (2010) revealed that most of the patients with DM were moderately active which is not in agreement with the findings of the current study. Çolak et al. (2016) also revealed that the largest proportion of participants with DM in their study had moderate activity levels. Furthermore, QoL (from D-39 scores) was demonstrated to have a statistically significant negative correlation with level of PA indicating that PA has a positive impact on QoL (Çolak et al., 2016).

Regular PA is regarded as one of the cornerstones of lifestyle modification in the prevention and management of diabetes (Colberg et al., 2010). Research has demonstrated that increased PA significantly improves blood glucose control in persons with diabetes mellitus (Umpierre et al., 2011). Although the benefits of regular PA are becoming more widely known, people often find it difficult to incorporate structured exercise into their previously sedentary lives (Colberg et al., 2010). Studies have indicated that individuals with diabetes engage in

Table 1. Socio-demographic characteristics and quality of life of study respondents.

Variable	n	%
Age (Mean = 54.61)		
<40 years	11	8.9
40-60 years	80	64.5
60-80 years	28	22.6
>80 years	5	4
Gender		
Male	48	38.7
Female	76	61.3
BMI		
<18.5	6	4.8
18.5-25.0	75	60.5
25.1-30.0	24	19.4
30.1-35.0	15	12.1
35.1-40	3	2.4
>40	1	0.8
Duration of diabetes		
<10 years	93	75.0
≥10 years	31	25.0
Quality of life		
Physical summary component		
<50	107	86.3
≥50	17	13
Mental summary component		
<50	71	57.3
≥50	53	42.7

less physical activities than the general populace (Adeniyi et al., 2012; Oyewole et al., 2014).

The QoL result of less than 50% for the majority of the respondents was not in harmony with a range between 19 and 28 indicating good QoL for the majority of the participants in a previous research (Oguntibeju et al., 2012) in which it was concluded that the participants had a fairly good QoL. In a study conducted in Erbil city of Iraq, diabetic patients of all age groups had low scores in all domains of QoL (Asa`ad, Othman, Ismail and Al-Hadithi, 2019) which supports the present findings. Other studies also reported decreased QoL among patients with diabetes et al., 2009).

Improved QoL and good glycaemic control have been recognised as independent and achievable outcomes in diabetes management (Kolawole et al., 2009) and have great potential as clinical markers that could be used to identify individuals with diabetes who are at higher risk of adverse outcomes (Li et al., 2013). Thus, improving QoL is a critical component of clinical management and public health services for people with diabetes.

The findings of the present study also indicate that a significant number of the respondents had suboptimal sleep duration (less than 6 hours of nighttime sleep episode). These suboptimal sleepers are at risk of having difficult-to-control diabetes. Studies have demonstrated that decreases in glucose tolerance and insulin sensitivity after a short sleep, as shown by increased hepatic glucose production and reduced peripheral glucose disposal (Klingenberg et al., 2013; Spiegel et al., 1999) could be the culprit. Additionally, short sleep could result in an insulin-resistant state in human adipocytes through the reduction of phosphorylation of Protein Kinase B (PKB) suggesting that sleep might be an important regulator of energy metabolism in peripheral tissues (Broussard et al., 2012). PKB signaling plays a central role in insulin-stimulated glucose uptake in both muscle and adipose tissues (George et al., 2004) and reduced

Table 2. Correlation between physical activity and clinical variables.

Variable		PA	DSL
DSL	Coeff	0.160	-
	p	0.075	-
Quality of Life (QoL)			
SF-36 PSC	Coeff	0.071	-0.009
	p	0.435	0.923
SF-36 MSC	Coeff	-0.080	-0.086
	p	0.379	0.341

DSL, Duration of sleep; PA, Physical activity; SF-36 PSC, Short Form 36 health survey physical summary component of QoL; SF-36 MSC, Short Form 36 health survey mental summary component of QoL. *p* values are for Spearman correlation statistics.

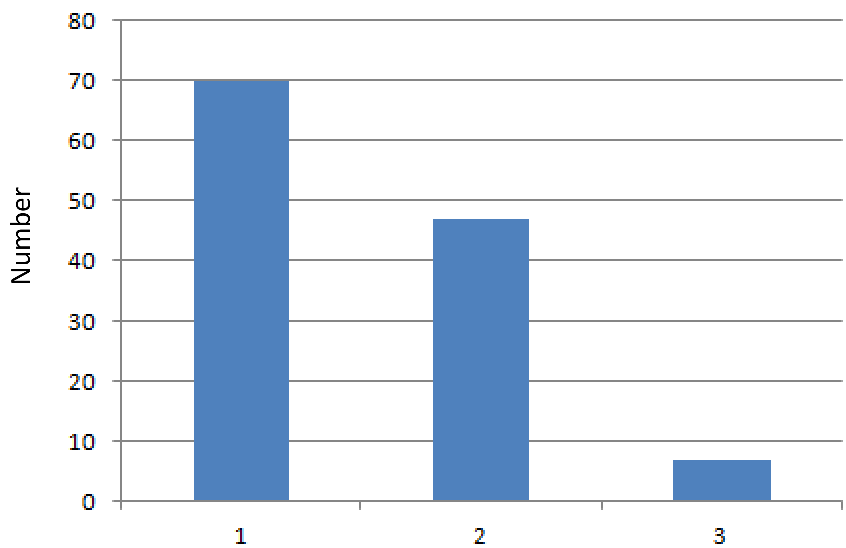

Figure 1. Physical activity level of the respondents. 1 = Low, 2 = Moderate, 3 = High.

phosphorylation of PKB is linked to insulin resistance through negative insulin receptor substrate functions (Zick, 2001), reduced phosphatidylinositol 3-kinase (PI3K) activity (Tremblay et al., 2001), and impaired phosphorylation of the PKB substrate AS160 (Karlsson et al., 2005). Short sleep duration has also been shown to be associated with increased levels of inflammation markers (Williams et al., 2007), and sleep disruption may be related to diabetes via the mechanisms of low-grade systemic inflammation and sleep-inducing effects of the inflammatory state (Zizi et al., 2010). Thus, sleep of short duration is associated with higher risk for various health outcomes including diabetes.

The non-significant correlation between PA and sleep duration was found to be due to the majority of the respondents experiencing either short sleep duration or longer than the optimal number of hours for sleep which may exacerbate their condition (diabetes). This might be true about the non-significant correlation between PA and QoL as well as that between sleep duration and QoL. These non-significant correlations might also be attributed to majority of the respondents being within the low PA category.

Limitations of the study

This study was not without limitations. First, the correlations between PA and socio-demographic variables of the selected population were not explored. Second, the study did not assess the predictors of PA, QoL and sleep among diabetic patients. In addition, our sample size was

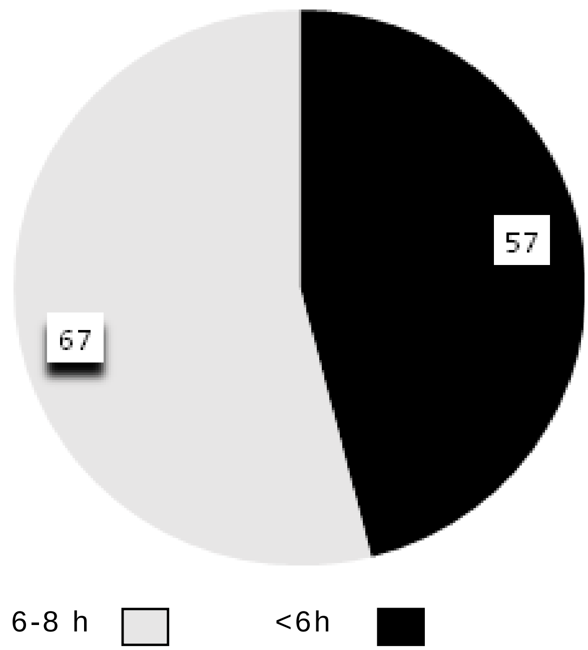

Figure 2. Sleep duration as reported by the respondents.

not based on power calculation. Thus, the results are not a precise reflection of the characteristics of all patients with DM in the population and cannot, therefore, be generalizable. However, we are optimistic that our findings have enriched the literature. Future studies may be conducted to address these issues.

Conclusion

It was concluded that the majority of the individuals with diabetes mellitus in the selected health facilities were not meeting any of the criteria for either moderate or high levels of physical activity with sleep duration in a significant proportion of them being suboptimal for good quality of life and general wellbeing. Emphasis should be made on information about the benefits of regular physical exercise and adequate sleep in diabetes management.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES

Adeghate E, Schattner P, Dunn E (2006). An update on the etiology and epidemiology of diabetes mellitus. In Annals of the New York Academy of Sciences (1084):1-29). Blackwell Publishing Inc. https://doi.org/10.1196/annals.1372.029

Adeniyi A, Idowu O, Ogwumike O, Adeniyi C (2012). Comparative influence of self-efficacy, social support and perceived barriers on low physical activity development in patients with type 2 diabetes, hypertension or stroke. Ethiopian Journal of Health Sciences 22(2):113-119. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/22876075

Adeniyi AF, Fasanmade AA, Aiyegbusi OS, Uloko AE (2010). Physical activity levels of type 2 diabetes patients seen at the outpatient diabetes clinics of two tertiary health institutions in Nigeria. Nigerian Quarterly Journal of Hospital Medicine 20(4):165-170.

American Diabetes Association (2018). 3. Comprehensive Medical Evaluation and Assessment of Comorbidities: Standards of Medical Care in Diabetes-2018. Diabetes care 41(Suppl 1):S28–S37. https://doi.org/10.2337/dc18-S003

Asa`ad Y, Othman S, Ismail S, Al-Hadithi T (2019). Quality of life of type 2 diabetic patients in Erbil city. Zanco Journal of Medical Sciences 23(1):35-42. https://doi.org/10.15218/zjms.2019.005

Ayas NT, White DP, Manson JAE, Stampfer MJ, Speizer FE, Malhotra A, Hu FB (2003). A prospective study of sleep duration and coronary heart disease in women. Archives of Internal Medicine 163(2):205-209. https://doi.org/10.1001/archinte.163.2.205

Beccuti G, Pannain S (2011). Sleep and obesity. Current Opinion in Clinical Nutrition and Metabolic Care. NIH Public Access. https://doi.org/10.1097/MCO.0b013e3283479109

Bromley LE, Booth JN, Kilkus JM, Imperial JG, Penev PD (2012). Sleep Restriction Decreases the Physical Activity of Adults at Risk for Type 2 Diabetes. Sleep 35(7):977-984. doi:10.5665/sleep.1964

Broussard JL, Ehrmann DA, Van Cauter E, Tasali E, Brady MJ (2012). Impaired insulin signaling in human adipocytes after experimental sleep restriction: A randomized, crossover study. Annals of Internal Medicine 157(8):549-557. https://doi.org/10.7326/0003-4819-157-8-201210160-00005

Buysse DJ, Reynolds CF, Monk TH, Berman SR, Kupfer DJ (1989). The Pittsburgh sleep quality index: A new instrument for psychiatric practice and research. Psychiatry Research 28(2):193-213. https://doi.org/10.1016/0165-1781(89)90047-4

Cappuccio FP, D'Elia L, Strazzullo P, Miller MA (2010). Quantity and quality of sleep and incidence of type 2 diabetes: A systematic review and meta-analysis. Diabetes Care 33(2):414-420. https://doi.org/10.2337/dc09-1124

Caspersen CJ, Powell KE, Christenson GM (1985). Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. Public Health Reports 100(2):126-31.

Cincin A, Sari I, Oguz M, Sert S, Bozbay M, Atas H, Ozben B, Tigen K, Basaran Y (2015). Effect of acute sleep deprivation on heart rate recovery in healthy young adults. Sleep Breath 19(2):631-636.

Çolak TK, Acar G, Dereli EE, Özgül B, Demirbüken İ, Alkaç Ç, Polat MG (2016). Association between the physical activity level and the quality of life of patients with type 2 diabetes mellitus. Journal of Physical Therapy Science 28(1):142-147. https://doi.org/10.1589/jpts.28.142.

Colberg SR, Sigal RJ, Fernhall B, Regensteiner JG, Blissmer BJ, Rubin RR, Braun B (2010). Exercise and type 2 diabetes: The American College of Sports Medicine and the American Diabetes Association: Joint position statement. Diabetes Care. https://doi.org/10.2337/dc10-9990

Craig CL, Marshall AL, Sjöström M, Bauman AE, Booth ML, Ainsworth BE, Oja P (2003). International physical activity questionnaire:12-Country reliability and validity. Medicine and Science in Sports and Exercise 35(8):1381-1395. https://doi.org/10.1249/01.MSS.0000078924.61453.FB

Davies SK, Ang JE, Revell VL, Holmes B, Mann A, Robertson FP, Cui N, Middleton B, Ackermann K, Kayser M (2014). Effect of sleep deprivation on the human metabolome. Proceedings of the National Academy of Sciences 111:10761-10766.

Dolezal BA, Neufeld EV, Boland DM, Martin JL, Cooper CB (2017). Interrelationship between Sleep and Exercise: A Systematic Review. Advances in Preventive Medicine 1-14. doi:10.1155/2017/1364387

Eckert K (2012). Impact of physical activity and bodyweight on health-related quality of life in people with type 2 diabetes. Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy 5:303-311. https://doi.org/10.2147/dmso.s34835

Fava GA, Tomba E, Sonino N (2012). Clinimetrics: the science of clinical measurements. International Journal of Clinical Practice 66(1):11-5.

Frank E, Sidor MM, Gamble KL, Cirelli C, Sharkey KM, Hoyle N, Tikotzky L, Talbot LS, McCarthy MJ, Hasler BP. (2013). Circadian clocks, brain function, and development. Annals of the New York Academy of Sciences 1306:43-67.

George S, Rochford JJ, Wolfrum C, Gray SL, Schinner S, Wilson JC, Barroso I (2004). A family with severe insulin resistance and diabetes due to a mutation in AKT2. Science 304(5675):1325-1328. https://doi.org/10.1126/science.1096706

Grandner MA, Patel NP, Perlis ML, Gehrman PR, Xie D, Sha D, Gooneratne NS (2011). Obesity, diabetes, and exercise associated with sleep-related complaints in the American population. Journal of Public Health 19(5):463-474. https://doi.org/10.1007/s10389-011-0398-2.

Hadiza S (2018). Mortality patterns in the Medical Wards of Murtala Muhammad Specialist Hospital, Kano, Nigeria. Nigerian Journal of Basic Clinical Sciences 15:73-76.

Hagströmer M, Oja P, Sjöström M (2006). The International Physical Activity Questionnaire (IPAQ): a study of concurrent and construct validity. Public health nutrition 9(6):755-762. https://doi.org/10.1079/phn2005898

Ibrahim AA, Akindele MO, Ganiyu SO, Kaka B, Abdullahi BB, Sulaiman SK Fatoye F (2020). The Hausa 12-item short-form health survey: Translation, cross-cultural adaptation and validation in mixed urban and rural Nigerian populations with chronic low back pain. PloS ONE 15(5):e0232223. https://doi.org/10.1371/journal.pone.0232223

International Diabetes Federation (2019). IDF Diabetes. International Diabetes Federation Diabetes Atlas, Ninth Edition. Retrieved from https://www.diabetesatlas.org/en/

International Diabetes Federation (2021). IDF virtual congress 2021. Retrieved from https://www.idf.org/our-activities/congress/idf-congress-2021.html

Janssen I, Heymsfield SB, Ross R (2002). Low relative skeletal muscle mass (sarcopenia) in older persons is associated with functional impairment and physical disability. Journal of the American Geriatrics Society 50(5):889-896.https://doi.org/10.1046/j.1532-5415.2002.50216.x

Karlsson HKR, Zierath JR, Kane S, Krook A, Lienhard GE, Wallberg-Henriksson H (2005). Insulin-stimulated phosphorylation of the Akt substrate AS160 is impaired in skeletal muscle of type 2 diabetic subjects. Diabetes 54(6):1692-1697. https://doi.org/10.2337/diabetes.54.6.1692

Kawakami N, Takatsuka N, Shimizu H (2004). Sleep Disturbance and Onset of Type 2 Diabetes [11]. Diabetes Care. American Diabetes Association. https://doi.org/10.2337/diacare.27.1.282

Kiadaliri AA, Najafi B, Mirmalek-Sani M (2013). Quality of life in people with diabetes: a systematic review of studies in Iran. Journal of Diabetes and Metabolic Disorders 12(1):54.

Klevsgård R, Fröberg BL, Risberg B, Hallberg IR (2002). Nottingham Health Profile and Short-Form 36 Health Survey questionnaires in patients with chronic lower limb ischemia: Before and after revascularization. Journal of Vascular Surgery 36(2):310-317. https://doi.org/10.1067/mva.2002.125747

Klingenberg L, Chaput JP, Holmbäck U, Visby T, Jennum P, Nikolic M, Sjödin A (2013). Acute sleep restriction reduces insulin sensitivity in adolescent boys. Sleep 36(7):1085-1090. https://doi.org/10.5665/sleep.2816

Kolawole BA, Mosaku SK, Ikem RT (2009). A comparison of two measures of quality of life of nigerian clinic patients with type 2 diabetes mellitus. African Health Sciences 9(3):161-166. https://doi.org/10.4314/ahs.v9i3.49002

Konstabel K, Lönnqvist JE, Leikas S, Velázquez RG, Qin H, Verkasalo M, Walkowitz G (2017). Measuring single constructs by single items: Constructing an even shorter version of the “Short Five” personality inventory. PLoS ONE 12(8):1-19. https://doi.org/10.1371/journal.pone.0182714

Kumar V, Tripathi M, Chauhan P, Singh P (2013). Different non-pharmacological approaches for management of type 2 diabetes. Journal of Diabetology 1(6):13. Retrieved from https://www.journalofdiabetology.org/article.asp?issn=2078-7685;year=2013;volume=4;issue=1;spage=1;epage=1;aulast=Kumar;type=0

Lee PH, Macfarlane DJ, Lam TH, Stewart SM (2011). Validity of the international physical activity questionnaire short form (IPAQ-SF): A systematic review. International Journal of Behavioral Nutrition and Physical Activity 8(21):115. https://doi.org/10.1186/1479-5868-8-115

Li CL, Chang HY, Hsu CC, Lu J, fen R, Fang HL (2013). Joint predictability of health related quality of life and leisure time physical activity on mortality risk in people with diabetes. BMC Public Health 13(1):67. https://doi.org/10.1186/1471-2458-13-67

Lyons RA, Perry IM, Littlepage BNC (1994). Evidence for the validity of the short-form 36 questionnaire SF-36 in an elderly population. Age and Ageing 23(3):182-184. https://doi.org/10.1093/ageing/23.3.182

Maharaj SS, Nuhu JM (2015). The effect of rebound exercise and treadmill walking on the quality of life for patients with non-insulin-dependent type 2 diabetes. International Journal of Diabetes in Developing Countries 35:223-229. https://doi.org/10.1007/s13410-015-0350-z

Marianna A, Protogerou G, Tsoucalas G, Androutsos EPR (2016). Milestones in the history of diabetes mellitus: The main contributors. World Journal of Diabetes 7(1):1. https://doi.org/10.4239/wjd.v7.i1.1

Maruish M, Maruish M, Kosinski M, Bjorner J, Gandek B, Turner-Bowker D, Ware J (2011). User’s manual for the SF36v2 Health Survey. Quality Metric Incorporated. Retrieved from https://www.scienceopen.com/document?vid=0a250605-f5f8-489a-a73c-329de570f424

Maruish ME (2011) User’s manual for the SF-36v2 Health Survey 3. Lincoln, RI: Quality Metric Incorporated.

McDowell I (2009). Measuring Health: A guide to rating scales and questionnaires. Measuring Health: A Guide to Rating Scales and Questionnaires 2. Oxford University Press. https://doi.org/10.1093/acprof:oso/9780195165678.001.0001

McHorney CA, Ware JE, Rachel JF, Sherbourne CD (1994). The MOS 36-item short-form health survey (SF-36): III. Tests of data quality, scaling assumptions, and reliability across diverse patient groups. Medical Care 32(1):40-66. https://doi.org/10.1097/00005650-199401000-00004

National Institutes of Health, National Heart, Lung, and Blood Institute (1998). Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults: the evidence report. Obesity Research 6(2):51-210.

Oguntibeju OO, Odunaiya N, Oladipo B, Truter EJ (2012). Health behaviour and quality of life of patients with type 2 diabetes attending

selected hospitals in south western Nigeria. The West Indian Medical Journal 61(6):619-626.
Oyewole O, Odusan O, Oritogun K, Idowu A (2014). Physical activity among type-2 diabetic adult Nigerians. Annals of African Medicine 13(4):189. https://doi.org/10.4103/1596-3519.142290
Oyeyemi AL, Oyeyemi AY, Adegoke BO, Oyetoke FO, Aliyu HN, Aliyu SU, Rufai AA (2011). The Short International Physical Activity Questionnaire: cross-cultural adaptation, validation and reliability of the Hausa language version in Nigeria. BMC Medical Research Methodology 11:156. https://doi.org/10.1186/1471-2288-11-156
Öztürk ZA, Yesil Y, Kuyumcu ME, Savas E, Uygun Ö, Sayıner ZA, Kepekçi Y (2015). Association of depression and sleep quality with complications of type 2 diabetes in geriatric patients. Aging Clinical and Experimental Research 27(4):533-538. https://doi.org/10.1007/s40520-014-0293-0
Rechtschaffen A, Bergmann BM, Everson CA, Kushida CA, Gilliland MA. (1989). Sleep deprivation in the rat. X. Integration and discussion of the findings. Sleep 12(1):68-87.
Shiriyedeve S, Dlungwane TP, Tlou B (2019). Factors associated with physical activity in type 2 diabetes mellitus patients at a public clinic in Gaborone, Botswana, in 2017. African Journal of Primary Health Care and Family Medicine 11(1):2036. https://doi.org/10.4102/phcfm.v11i1.2036
Skomro RP, Ludwig S, Salamon E, Kryger MH (2001). Sleep complaints and restless legs syndrome in adult type 2 diabetics. Sleep Medicine 2(5):417-422. https://doi.org/10.1016/S1389-9457(01)00110-1
Snel M, Sleddering MA, Vd Peijl ID (2012). Quality of life in type 2 diabetes mellitus after a very low calorie diet and exercise. European Journal of Internal Medicine 23(2):143-149.
Spiegel K, Leproult R, Van Cauter E (1999). Impact of sleep debt on metabolic and endocrine function. Lancet 354(9188):1435-1439. https://doi.org/10.1016/S0140-6736(99)01376-8
Stewart A, Marfell-Jones M, Olds T, Ridder H (2011). International standards for anthropometric assessment. Lower Hutt, New Zealand: International Society for the Advancement of Kinanthropometry (ISAK).
St-Onge MP, Grandner MA, Brown D, Conroy MB, Jean-Louis G, Coons M, Bhatt DL (2016). American Heart Association Obesity, Behavior Change, Diabetes, and Nutrition Committees of the Council on Lifestyle and Cardiometabolic Health; Council on Cardiovascular Disease in the Young; Council on Clinical Cardiology; and Stroke Council. Sleep Duration and Quality: Impact on Lifestyle Behaviors and Cardiometabolic Health: A Scientific Statement From the American Heart Association. Circulation 134(18):e367-e386.
Surani S (2015). Effect of diabetes mellitus on sleep quality. World Journal of Diabetes 6(6):868. https://doi.org/10.4239/wjd.v6.i6.868
Thiel DM, Al Sayah F, Vallance JK, Johnson ST, Johnson JA (2017). Association between Physical Activity and Health-Related Quality of Life in Adults with Type 2 Diabetes. Canadian Journal of diabetes 41(1):58-63. https://doi.org/10.1016/j.jcjd.2016.07.004
Tremblay F, Lavigne C, Jacques H, Marette A (2001). Defective Insulin-Induced GLUT4 Translocation in Skeletal Muscle of High Fat-Fed Rats Is Associated with Alterations in Both Akt/Protein Kinase B and Atypical Protein Kinase C (ζ/λ) Activities. Diabetes 50(8):1901-1910. https://doi.org/10.2337/diabetes.50.8.1901
Umpierre D, Ribeiro PA, Kramer CK, Leitão CB, Zucatti AT, Azevedo MJ, Schaan BD (2011). Physical activity advice only or structured exercise training and association with HbA1c levels in type 2 diabetes: A systematic review and meta-analysis. JAMA - Journal of the American Medical Association 305(17):1790-1799. https://doi.org/10.1001/jama.2011.576
Wang F, Boros S (2019). The effect of physical activity on sleep quality: a systematic review. European Journal of Physiotherapy 23(1):11-18. doi:10.1080/21679169.2019.1623314
Ware JE, Ware J (1993). SF-36 Physical and Mental Health Summary Scales: a User's Manual Estimation of medical care total expenditures View project. Retrieved from https://www.researchgate.net/publication/292390260
Williams CJ, Hu FB, Patel SR, Mantzoros CS (2007). Sleep duration and snoring in relation to biomarkers of cardiovascular disease risk among women with type 2 diabetes. Diabetes Care 30(5):1233-1240. https://doi.org/10.2337/dc06-2107
World Health Organization (WHO) (2013). Diabetes. Retrieved from https://www.who.int/health-topics/diabetes#tab=tab_1
Xie L, Kang H, Xu Q, Chen MJ, Liao Y, Thiyagarajan M, O'Donnell J, Christensen DJ, Nicholson C, Iliff JJ (2013). Sleep drives metabolite clearance from the adult brain. Science 342(6156):373-377.
Zick Y (2001). Insulin resistance: A phosphorylation-based uncoupling of insulin signaling. Trends in Cell Biology. Trends in Cell Biology. https://doi.org/10.1016/S0962-8924(01)02129-8
Zizi F, Jean-Louis G, Brown CD, Ogedegbe G, Boutin-Foster C, McFarlane SI (2010). Sleep duration and the risk of diabetes mellitus: Epidemiologic evidence and pathophysiologic insights. Current Diabetes Reports 10(1):43-47. https://doi.org/10.1007/s11892-009-0082-x

APPENDIX

Physical activity categories and cut-off levels based on the IPAQ scoring protocol.

Physical activity category	Cut off levels
Low (1)	Scoring a low level of physical activity on the IPAQ means that one is not meeting any of the criteria for either moderate of high levels of physical activity (i.e., no activity is reported or some activity is reported but not enough to meet categories 2 or 3).
Moderate (2)	3 or more days of vigorous intensity activity for at least 20 min per day OR 5 or more days of moderate intensity activity or walking of at least 30 min per day OR 5 or more days of any combination of walking, moderate intensity or vigorous intensity activities achieving a minimum total physical activity of at least 600 MET minutes a week.
High (3)	3 or more days of vigorous intensity activity accumulating at least 1500 MET minutes a week OR 7 or more days of any combination of walking, moderate intensity or vigorous intensity activities achieving a minimum total physical activity of 3000 MET min a week.

Available at www.ipaq.ki.se