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RESEARCH

Habitual physical activity, peripheral neuropathy, foot deformities and lower limb function: characterising prevalence and interlinks in patients with type 2 diabetes mellitus

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Background: Patients with type 2 diabetes mellitus (T2DM) may have diverse foot problems, but how these problems are linked with physical activity is not clear. This study investigated the prevalence of foot problems among patients with T2DM and investigated how the problems were related to physical activity.
Methods: Habitual physical activity, peripheral neuropathy, lower limb functions and foot deformities of 246 T2DM patients were respectively assessed with the Baecke Physical Activity Questionnaire, Michigan Neuropathy Screening Instrument, Lower Limb Function Scale, and a self-designed foot deformity audit form.
Results: Habitual physical activity index (3.2 ± 0.83) was highest in work-related activities; 69 (26.1 %) patients presented with peripheral neuropathy and 52 (19. 7%) had the lowest limb function. Pes planus was the most prevalent foot deformity (20.1%). Significant differences existed in physical activity indices across deformity groups ($p < 0.05$) and total activity index was related to neuropathic and lower limb function scores ($p < 0.05$).
Conclusion: A higher work-related but reduced participation in sports and leisure time physical activity among the patients was observed. Habitual physical activity was lowest in patients with a forefoot deformity, higher neuropathic scores and lesser lower limb function scores. Patients with T2DM in these categories may be a target for special physical activity intervention programmes.

Keywords: diabetes mellitus, foot complications, physical activity

Introduction

Diabetes mellitus affects millions of people worldwide[1,2] and physical activity has been identified to play multiple roles in regulating the disorder. Physical activity prevents diabetes in those who are yet to be affected,[3–7] and helps to maintain and improve glycaemic control including the general control of the disorder among those who have it.[8–12] In other words, physical activity is relevant at every stage of the diabetes continuum; hence people who already have the disorder are expected to be persistently active. It has, however, been documented that most patients with diabetes do not engage in physical activities at recommended levels.[13–17] Many reasons for their physical inactivity have been reported and these include issues like fear of hypoglycaemia and perceptions and understandings of the impact of the activities upon their future health.[18,19] Other reasons include lack of time[18,20] and physical limitations that hindered activity (e.g. joint or leg pain), lack of equipment, and exercise partner(s).[20] Yet, many of these patients have one form of neuromusculoskeletal disorder or another,[16, 21–24] especially the ones affecting the lower limbs.[20,25] The vital roles of the lower limbs in ambulatory functions are obvious, but the likely influences of lower limb neuromusculoskeletal disorders on the overall physical activity of people with type 2 diabetes mellitus (T2DM) have not received so much attention. This study was therefore conducted to investigate the links among physical activity and selected indices of neuromusculoskeletal disorders including foot deformities, peripheral neuropathy and lower limb functions among a group of Nigerian patients with T2DM.

Methodology

Participants

Participants in this study were T2DM patients who were receiving care at the Endocrinology Clinic of the Medical Out-patient Clinic of the University College Hospital (UCH), Ibadan and Diabetes Clinic of the Medical Out-patient Clinic of Ring Road State Hospital (RRSH), Ibadan. The former is a tertiary health centre while the latter is a secondary health centre. The tertiary health facility is managed by the Federal Government of Nigeria, while the secondary facility is managed by the Oyo State Government of Nigeria. An initial assessment found 433 T2DM patients were treated in both hospitals during the study period. Based on this information, a decision was reached to include all eligible patients in the study since there were less than 500. The eligibility criterion was being diagnosed with T2DM for at least six months, while exclusion criteria included memory loss, blindness, lower limb amputation and foot ulcer. Patients who declined to give consent and those who for one reason or another had been asked to stay off physical activity and exercise by their physicians were also excluded.

Procedure

This study was a cross-sectional survey of hospital-based patients with T2DM. Ethical approval for the study was sought and obtained from the University of Ibadan/University College Hospital Research Ethics Committee (ID: UI/EC/12/0395). Informed consent of the participants, after the purpose and procedure of the study had been explained to them, as well as approval of the physicians managing them were also obtained.

Some clinical and demographic data such as age, gender, occupation, duration of diagnosis, additional health problems etc. were also documented. The instruments for this study were: Baecke's Habitual Physical Activity Questionnaire, the Michigan Neuropathy Screening Instrument and the Lower Extremity Functional Scale. Others include a tuning fork, Semmes–Weinstein monofilament, reflex hammer and a self-designed foot deformity form.

Baecke's Habitual Physical Activity Questionnaire (BHPAQ)

The BHPAQ is a self-administered generic questionnaire that is used to objectively assess habitual physical activity of individuals. It was developed and first used in the Netherlands to investigate self-reported physical activity by Baecke et al.[26] The questionnaire examines habitual physical activity level using 16 questions categorised under: *Work activity* – assesses physical activity level based on occupation, frequency of sitting, standing, walking, lifting, sweating etc. at work; *Sports activity* – assesses activity level based on frequency of sweating while engaging in sport, leisure time sporting activity, duration of sporting activity etc; *Leisure activity* – assesses activity level based on duration of watching television, walking, cycling, etc. during leisure activities. The BHPAQ employs a five-point ordinal scale in assessing responses to the questions ranging from never to sometimes to always.

Each category of habitual physical activity is scored and graded as follows:[26] Work activity is graded as work index = [(6 – (points for sitting)) + SUM(points for the other 7 parameters)] / 8. Sports activity is graded as sport index = (SUM(points for all 4 parameters)) / 4. Leisure activity is graded as leisure index = [6 – (points for television watching) + SUM(points for remaining 3 items)] / 4. The BHPAQ has been frequently used in many studies as a general measure of physical activity[27–31] and it was also found to be highly reliable and valid for both men and women.[26,32] In a study by Hertogh et al.[33] to examine the validity of BHPAQ, the score of BHPAQ was assessed among 21 elderly men and women using the doubly labelled water method as the reference criterion. The study found the validity of BHPAQ to be fair-to-moderate with Spearman's correlation coefficient between the questionnaire score and the physical activity ratio as 0.54 (95% CI 0.22–0.66).

The Lower Extremity Functional Scale (LEFS)

The LEFS is a questionnaire containing 20 questions about a person's ability to perform everyday tasks.[34] It is used to evaluate the functional impairment of patients with a disorder of one or both lower extremities, and to monitor the patient over time and evaluate the effectiveness of intervention. It is a self-administered questionnaire that uses a five-point ordinal scale (0–4) to assess functional limitations in activities of daily living involving use of lower limbs. These activities include walking between rooms, squatting, lifting an object like a bag from the floor, standing, sitting, getting into or out of the bath etc. Participants answer the question 'Today, do you or would you have any difficulty at all with…' in regard to the 20 different activities, selecting an answer from the following scale for each activity listed: Extreme difficulty or unable to perform activity; Quite a bit of difficulty; Moderate difficulty; A little bit of difficulty; and No difficulty. The least possible score is 0 indicating very low function and the maximum possible score is 80 indicating very high function. The lower the score, the greater the disability. The LEFS has been found to be a very valid instrument in the measurement of function in the lower extremities. A study by Yeung et al.[35] to assess the reliability, validity and responsiveness of the lower extremity functional scale for inpatients of an orthopaedic rehabilitation ward found that interclass correlation coefficient of LEFS was 0.88.

The Michigan Neuropathy Screening Instrument (MNSI)

The MNSI was used to assess for the presence of neuropathic symptoms and the presence of peripheral neuropathy among participants.[36] It has two sections, with the first containing a 15-item self-administered questionnaire that requires a 'Yes' or 'No' response to questions on foot sensation including pain, numbness and temperature sensitivity. A higher score (out of a maximum score of 13 points) indicates more self-reported neuropathic symptoms.[36] Though there are 15 items in this section, only 13 of the items are used in scoring. This results from the fact that items 4 and 10 are measures of impaired circulation and general asthenia respectively; these are not symptoms of peripheral neuropathy and were thus not included in scoring. The second section of the MNSI is a five-item clinician-administered questionnaire, which is a brief physical examination involving inspection of the feet for deformities, dry skin, hair or nail abnormalities, callus or infection. It also included a semi-quantitative assessment of vibration sensation at the dorsum of the great toe, grading of ankle reflexes, and monofilament testing. Patients screening positive on the clinical portion of the MNSI are those with scores greater than 2 points on the 10-point scale and are considered neuropathic.[36] A cross-sectional study over a 2-year period on 176 T2DM patients using MNSI scores of 1.5, 2.0, 2.5 and 3.0 as cut-off values showed sensitivities to be 79%, 65%, 50% and 35% respectively and specificities were 65%, 83%, 91% and 94%, respectively. Positive predictive values increased and negative predictive values decreased for each score.[37]

Tuning fork

Vibration sensation was performed on the great toe with the toe unsupported. It was tested bilaterally using a 128 Hz tuning fork placed over the dorsum of the great toe on the bony prominence of the distal interphalangeal joint. With patients' eyes closed, they were asked to indicate when they could no longer sense the vibration from the vibrating tuning fork.[36] In general, the examiner should be able to feel vibration from the hand-held tuning fork for 5 s longer on his distal forefinger than a normal subject can at the great toe (e.g. examiner's DIP joint of the first finger versus patient's toe). If the examiner feels vibration for 10 or more seconds on his or her finger, then vibration is considered decreased.[36,38,39] Vibration is scored as (1) present if the examiner senses the vibration on his or her finger for < 10 s, (2) reduced if sensed for ≥ 10 s, or (3) absent (no vibration detection).[36]

Semmes–Weinstein Monofilament (SWM)

The SWM is a nylon string specifically calibrated in stiffness to represent a baseline level of sensation that can be considered 'the line' between having neuropathy and having normal sensation.[40] When it is placed against the foot and slightly bent due to the pressure of pushing it onto the foot, a person with normal sensation should feel it. Eight correct responses out of 10 applications are considered normal: one to seven correct responses indicate reduced sensation and no correct answers translate into absent sensation.[36]

Reflex hammer

A reflex hammer was used to test deep tendon reflexes, an important part of the neurological physical examination in order to detect abnormalities in the central or peripheral nervous system. The ankle reflex was elicited by holding the relaxed foot with one hand and striking the Achilles tendon just above the heel with the hammer and noting plantar flexion. This was done on both limbs. The Achilles tendon was percussed directly. If a reflex was obtained, it was graded as present. If the reflex was absent, the patient was asked to perform the Jendrassic manoeuvre (i.e.

hooking the fingers together and pulling). If the reflex was absent, even in the face of the Jendrassic manoeuvre, the reflex was considered absent.[36].

Foot deformity form

This form was designed for this study. It contained the list of possible foot deformities seen among patients with diabetes. The list(s) of deformities was/were ticked for each patient according to the clinical appearance of each foot.[39,41]

Data analysis

Data were summarised using descriptive statistics to present the mean, standard deviation, frequency distribution and percentages of age of participants, gender distribution of the variables, and prevalence of foot deformities, lower extremity function problems, peripheral neuropathy and habitual physical activity among the patients. Analysis of variance (ANOVA) was used to compare physical activity scores across categories of foot deformities and Spearman's correlation coefficient was used to determine associations between scores of habitual physical activity and each of self-reported peripheral neuropathy symptom scores, peripheral neuropathy diagnosis scores and lower limb function scores. Level of significance was set at the 0.05 α level. All analyses were conducted using the IBM Statistical Package for Social Sciences (SPSS), version 20.0 (IBM, Armonk, NY, USA).

Results

The mean age of the participants was 59 ± 6.8 years (range = 39–74 years) and the majority of them (177, 67%) were females. Most of them (53%) had lower than tertiary education, 71% were married and more than half (59%) were in paid employment. Mean duration of diagnosis of T2DM was 7.3 years (ranging from 0.8 to 17 years) and most of them (162, 61.4%) were in paid employment. Co-morbidities reported by the participants include hypertension (101, 38.3%), osteoarthritis of the knees (56, 21.2%), eye problems (89, 33.7%), and back pain (49, 18.6%). The mean of the total physical activity index of the participants was 6.1 ± 1.56 and breakdown for each of the work, sports and leisure physical activity indices are presented in Table 1. The table also contains a summary of the distribution of self-reported neuropathic symptom scores of the participants, the distribution of neuropathic diagnosis scores and the distribution of lower limb function scores. A total of 19 (7.2%) patients had a self-reported neuropathic symptom score of 10 and above, 69 (26.1%) had a diagnosis score of 2 and over and 52 (19.7%) were in the poorest quarter for disability of the lower limb score.

The distribution of foot deformities seen among the participants is presented in Figure 1. The most observed singular foot deformity was pes planus, seen among 53 (20.1%) of the participants while 27 (10.2%) presented with multiple feet deformities. Patient-estimated duration of foot deformity ranged from two to eight years. Only 56 (21.2%) of the participants did not present with any deformity. A breakdown of the self-reported neuropathic symptoms reported by the participants is presented in Table 2. Of the 15 possible symptoms, the most reported was having 'hurtful legs' during walking among 103 (39%) of the participants and this was followed by 'leg/feet numbness' reported by 92 (34.8%) of the participants.

For the sake of analysis to characterise the link between physical activity and foot deformity, the deformities were further grouped into three broad categories including those affecting the forefoot, those affecting the mid or hind foot and those with multiple affectations (affecting all the regions of the foot (Table 3). Mean index for all categories of physical activity was highest among patients who presented with no foot deformity compared with those with foot deformities [work index (F = 68.155), sports index (F = 41.395), leisure index (F = 5.312) and total physical activity index (F = 31.714), $p < 0.05$ for all]. Among those with foot deformities, those with at least a forefoot affectation presented with the lowest physical activity indices.

Table 1: Summary of clinical findings

	Mean ± SD
Physical activity	
Work activity	3.2 ± 0.83
Sports activity	1.3 ± 0.37
Leisure activity	1.6 ± 0.59
Total activity	6.1 ± 1.56
Diabetic peripheral neuropathy	
Self-reported neuropathic symptom scores*	*n* (%)
< 5	167 (63.3)
5–9	78 (29.5)
≥ 10	19 (7.2)
Neuropathic diagnosis scores**	*n* (%)
< 2	195 (73.9)
≥ 2	69 (26.1)
Lower limb function***	*n* (%)
0–20	52 (19.7)
21–40	32 (12.1)
41–60	97 (36.7)
61–80	83 (31.4)

Notes: *A higher score out of a maximum of 13 points indicates more neuropathic symptoms.
**Greater than 2 points on a 10-point scale are considered neuropathic.
***The lower the score the greater the disability.

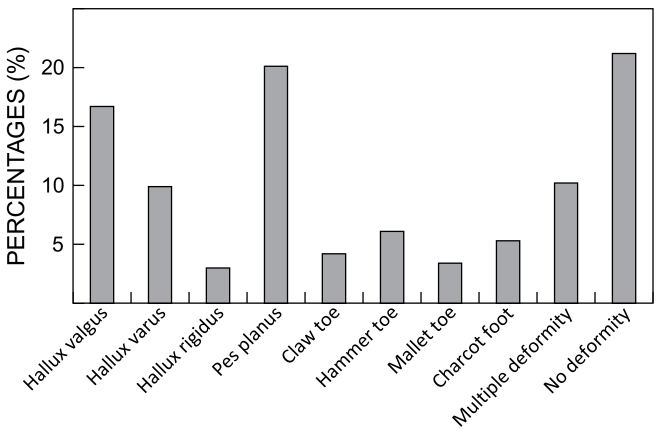

Figure 1: Foot deformities.

Table 2: Patients' self-report of neuropathic symptoms

Question		Yes *n* (%)	No *n* (%)
1.	Are your legs and/or feet numb?	92 (34.8)	172 (65.2)
2.	Do you ever have any burning pain in your legs and/or feet?	74 (28.0)	190 (72.0)
3.	Are your feet too sensitive to touch?	31 (11.7)	233 (88.3)
4.	Do you get muscle cramps in your legs and/or feet?	67 (25.4)	197 (74.6)
5.	Do you ever have any prickling feelings in your legs or feet?	59 (22.3)	205 (77.7)
6.	Does it hurt when the bed covers touch your skin?	9 (3.4)	255 (96.6)
7.	When you get into the tub or shower, are you able to tell the hot water from the cold water?	199 (75.4)	65 (24.6)
8.	Have you ever had an open sore on your foot?	11 (4.2)	253 (95.8)
9.	Has your doctor ever told you that you have diabetic neuropathy?	24 (9.1)	240 (90.9)
10.	Do you feel weak all over most of the time?	61 (23.1)	203 (76.9)
11.	Are your symptoms worse at night?	28 (10.6)	236 (89.4)
12.	Do your legs hurt when you walk?	103 (39.0)	161 (61.0)
13.	Are you able to sense your feet when you walk?	228 (86.4)	36 (13.6)
14.	Is the skin on your feet so dry that it cracks open?	13 (4.9)	251 (95.1)
15.	Have you ever had an amputation?	0 (0.00)	264 (100)

Table 3: Comparison of categories of habitual physical activities across categories of foot deformities

	Foot deformity				*F* value	*p*- value
	Forefoot affectation (*n* = 114)	Hind/mid foot affectation (*n* = 67)	Combined affectation (*n* = 27)	No deformity (*n* = 56)		
Work activity	3.2 ± 0.71	3.8 ± 0.87	1.9 ± 0.32	4.5 ± 1.13	68.155	0.0001
Sports activity	1.3 ± 0.34	1.6 ± 0.91	1.2 ± 0.26	2.4 ± 0.81	41.395	0.0001
Leisure activity	2.0 ± 0.66	2.1 ± 0.83	1.6 ± 0.45	2.2 ± 0.52	5.312	0.001
Total activity	6.5 ± 1.81	7.5 ± 2.70	4.7 ± 1.33	9.1 ± 2.26	31.714	0.0001

Table 4 shows the association between physical activity scores and each of self-reported neuropathic symptoms scores, neuropathic diagnosis score and lower limb function score. It was observed that total physical activity was significantly related to self-reported neuropathic score (r = −0.81, p = 0.0001), neuropathic diagnosis score (r = −0.68, p = 0.001) and lower limb function score (r = 0.61, p = 0.002). There was, however, no significant association between leisure activity and any of the neuropathic and limb function scores ($p > 0.05$).

Discussion

This study was conducted among Nigerian patients with T2DM to investigate the prevalence of peripheral neuropathy, foot deformities and lower limb function limitations and to characterise how these problems are linked with habitual physical activity of the patients. The following observations were made: (i) habitual physical activity was highest in work-related activities and least in sports, (ii) about one out of every four of the patients presented with peripheral neuropathy, (iii) about one out of every five of the patients had the lowest quarter in performance of foot function, (iv) pes planus was the most prevalent foot deformity accounting for about one out of every five patients and (v) habitual physical activity was significantly lowest in patients who presented with forefoot deformities, had higher neuropathy and reduced limb function score.

The fact that most of the participants were engaged more in work-related activities compared with leisure time and sports-related physical activities could be explained from two points of view, which are both related to occupation. One is that more than half of them were in paid employment when the data was collected and about a quarter of them were engaged in one personal vocation or another. Second, more than half of them had less than a tertiary educational qualification. The second scenario means that the participants are likely to be involved in jobs that require a higher amount of activity level by virtue of their lower educational attainments. According to He and Baker,[42] work-related physical

Table 4: Association of physical activity category scores with neuropathic and lower limb function scores

	Self-reported neuropathic symptom score	Neuropathic diagnosis score	Lower limb function score
Work activity	r = −0.61* *p* = 0.002	r = −0.13 *p* = 0.135	r = 0.22 *p* = 0.141
Sports activity	r = −0.59* *p* = 0.01	r = −0.78* *p* = 0.001	r = 0.27 *p* = 0.264
Leisure activity	r = −0.27 *p* = 0.245	r = −0.19 *p* = 0.084	r = 0.39 *p* = 0.062
Total activity	r = −0.81* *p* = 0.0001	r = −0.68* *p* = 0.001	r = 0.61* *p* = 0.002

*Significant at $p < 0.05$.

activity showed the opposite relationship to race/ethnicity and education compared with leisure time physical activity, but education was found to be the most important determinant of work-related physical activity surpassing race/ethnicity, self-reported overall health, and mobility difficulties. It was, however, interesting to observe that the participants in this current study presented with a number of varied health problems in spite of the higher work-related activity displayed by the participants. This may be because of the observations made by a previous study where it was reported that persons with higher work-related physical activity belong to a lower socioeconomic class or position, and this category of individuals comprises the very ones who have a higher prevalence of obesity,[43] which is a risk factor for many of the health problems.

A diabetic peripheral neuropathy of about one in every four patients was observed in this study of a Nigerian population and this could be due to the fact that most of the participants in this study had been diagnosed for durations ranging from approximately 1 to 17 years. Within this period there could have been multiple periods of poor glycaemic controls on the part of the patients. It has been reported that the prevalence of diabetic peripheral neuropathy increased with age and duration of diabetes,[22,44] degree of hyperglycaemia, and lipid and blood pressure indices.[44] According to Boulton et al.[44], peripheral neuropathy was present in 20.8% (19.1–22.5%) of patients with diabetes duration less than 5 years and in 36.8% (34.9–38.7%) of those with diabetes duration greater than 10 years. The prevalence of peripheral neuropathy found in this present study of Nigerian T2DM patients is, however, similar to the prevalence reported among individuals with T2DM from other regions. For example, a study by Abbott et al.[45] in the general diabetic population in north-west England found the prevalence of peripheral neuropathy to be over 21%. This relatively lower prevalence rate could be due to cultural differences as peripheral neuropathy has been found to be influenced by location, being less in South Asians (14%) than Europeans (22%) and African Caribbeans (21%).[45] In a previous review, the prevalence of diabetic peripheral neuropathy from several studies was placed at about at about 4–88% at diagnosis to about 15–58% after a period of 10–20 years among people 30 years and older.[46] Similarly, the overall prevalence reported of a UK population from a multi-centre study was 32.1% (30.6–33.6%).[22]

The prevalence of peripheral neuropathy reported in the current study is lower than that reported by a previous study in Nigeria conducted by Unachukwu et al.[47] among 51 consecutive diabetes patients with foot ulcer/gangrene admitted to the hospital. The study found that 86.3% of the subjects had signs of neuropathy of mild to severe grades. This marked difference in prevalence is expected because the study of Unachukwu et al.[47] was conducted on a sample that already presented with foot ulcers and gangrene. Peripheral neuropathy is an established and a major precursor to diabetic foot ulcers.[48] However, another study by Ugoya et al.[49] among 120 diabetic patients reported a higher prevalence among patients attending Jos University Teaching Hospital, Nigeria. The study documented a prevalence rate of 75%. The reason for this wide disparity could not be explained but that particular study was carried out in the northern part of Nigeria, while the present study was carried out in south-west Nigeria. Relatively lower access to basic medical services, a situation that is more prominent in the northern part of Nigeria, may play some role in this. However, a study by Adejumo et al.[50] among 75 diabetes patients in Ibadan, Nigeria reported a prevalence rate (20%) that is close to that reported by the current study. This could partly be due to the fact that that study was conducted in the same location as the present study.

Out of the total score of 80 representing the best lower limb function, almost three-quarters of the participants scored above half, placing them on at least average performance in terms of lower limb function. However, almost 20% of them scored only within one-quarter of the total score. The reason for the poor lower limb function scores in this proportion of the participants is not fully known but it may not be unconnected with the fact that a sizeable number of them may be related to peripheral neuropathy. In addition, most participants – with the exception of only one in five cases – had at least one type of deformity on at least one of the limbs. Although important relationships have been shown between motor nerve conduction deficit and muscle weakness it is still not clear whether abnormal nerve function, leading to a decrease in muscle strength, could have been responsible for the development of foot deformities.[51]

Pes planus and hallux valgus were the most prevalent foot deformities reported by the patients. The prevalence of hallux valgus reported in this current study is similar to that documented by Nix et al.[52] with a prevalence estimate of 23% in adults aged 18–65 years and 35.7% in elderly people aged over 65 years. The prevalence of pes planus in this current study is higher than the 13.9% reported for a general population of Nigerians as demonstrated in a study by Ukoha et al.[53] among 649 adults aged 18–27 years in Anambra State, Nigeria. The higher prevalence in this current study may, however, not necessarily be linked with T2DM as the pes planus may have preceded the development of T2DM. It is also important to note that the population in the study by Ukoha et al.[53] was relatively younger than the population in the current study.

The fact that physical activity was lowest among persons with at least one deformity affecting the forefoot may have to do with the function of this part of the foot with regard to weight-bearing and propulsion of the body. The stage of propulsion that is basically performed by the forefoot forms the last stage of the stance phase, which is when the feet bear most of the weight. This activity may be placing a heavy burden on the forefoot in order to push the body forward. Because of this heavy burden, this particular stage of the ambulatory process may be associated with pain and discomfort thereby leading to avoidance on the part of the patients. An attempt to avoid this discomfort can therefore lead to reduced physical activity since the limbs are typically involved in most activities. This may explain why physical activity will be lower in patients who have an affectation of the forefoot compared with other parts of the foot. Inverse links were also found between habitual physical activity and peripheral neuropathy. Taking the activities individually, it was observed that only sports activity was significantly related to peripheral neuropathy, while work-related and leisure activities were not. Sports activities are a form of physical activity that demand higher use of the limbs and this may be a reason why people with more severe foot problems tend to avoid sports activities.[54] Also, according to Mueller et al.,[55] diabetic patients showed less ankle mobility, ankle moment, ankle power, velocity and stride length during walking than the non-diabetic group subjects. According to the authors, a significant decrease in ankle strength and mobility appeared to be the primary factor contributing to the altered walking patterns of the diabetic groups. If patients with peripheral neuropathy are unable to generate sufficient moments about the ankle during walking, it would be expected that they would take shorter steps and walk slower than individuals without peripheral neuropathy.[55]

The clinical correlation of this study is that, first, it has helped to complement the scanty data that were hitherto available on the prevalence of foot complications among patients with T2DM in Nigeria. This information shows the types of complications that are prevalent and this would help in making appropriate plans for the reduction of this burden by all concerned healthcare workers. Second, this study has shown how these complications affect the performance of physical activity by this group of patients. The implication of this is that it may assist diabetes healthcare providers in targeting the categories of diabetic patients that may not be regular in their physical activity programmes based on their prevalent foot complications and also anticipating the type of physical activity that will be thus be affected. This helps in proactive handling of such cases in respect of providing possible alternative physical activity programmes for such individuals.

There are, however, a number of limitations in this study. It should be noted that the study could not determine whether some of the foot complications, especially the foot deformities, were due to diabetes but only relied on the prevailing symptoms at the time of data collection. In addition, the possibility of peripheral artery disease among the patients could not be ruled out since it was not assessed in this study. Also, the links between habitual physical activity of the participants and their foot complications should be interpreted with caution because certain other psychosocial factors such as motivation, depression and social support may have played some remote roles in their physical activities. Even though Baecke's Habitual Physical Activity Questionnaire has been found to be valid elsewhere, it is yet to be validated in Nigeria and this should equally be noted as a limitation.

Conclusions

This study has shown a higher participation in work-related physical activity but reduced participation in sports and leisure time physical activity among patients with T2DM. It has also demonstrated a significant burden of peripheral neuropathy, foot deformities and poor lower limb function among these patients. It also shows that physical activity is likely to be reduced in T2DM patients with more severe peripheral neuropathy, with deformity affecting the forefoot, and in those with reduced lower limb function scores. Patients with T2DM presenting with any one or a combination of these lower limb complications may be a target group for more focused physical activity intervention programmes.

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