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ORIGINAL ARTICLE

Individuals with type 2 diabetes are at higher risk of chronic musculoskeletal pain: a study with diabetes cohort

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Abstract The relationship between type 2 diabetes (T2DM) and chronic musculoskeletal complaints (cMSCs) remains largely debated. We investigated the association between T2DM and cMSCs in a cohort of 347 participants. A cross-sectional design was employed using the modified Nordic musculoskeletal questionnaire to investigate the prevalence of chronic musculoskeletal symptoms (cMSS) defined by pain and/stiffness lasting ≥3 months during the past 12 months. Multiple logistic regressions were employed to estimate the odds ratio among the diabetics compared to those without diabetes at 95 % CI. Generally, there was a high prevalence of cMSS among the cohorts, chronic low back pain being the most common complaint both among the diabetics (83; 49.7 %) and non-diabetics (70; 38.9 %).T2DM was associated with a higher prevalence of cMSS in at least one body segment and in all the nine body regions studied. cMSS was 2.5 times more likely among persons with T2DM compared to those without diabetes. Also, individuals with T2DM are 29 times at risk of cMSP of the upper back and knee compared to healthy cohorts. T2DM is associated with a higher risk of cMSP, a risk which is increased for the peripheral system much the same as centrally located musculoskeletal structure.

Keywords Musculoskeletal disorders · Diabetes complications · Musculoskeletal complication

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Background

Diabetes mellitus (DM) is a multi-system condition characterized by persistent hyperglycemia with both acute and chronic biochemical and anatomical sequelae. Type 2 DM represents approximately 90 % of all cases of diabetes [1]. Comorbid chronic pain is very common in type 2 diabetes mellitus (T2DM) due to the presence of diabetic neuropathy and musculoskeletal condition that are associated with prolonged hyperglycemia [2–4].

Although neuropathic pain is the most common type of comorbid pain studied in T2DM, recent studies have shown that several types of chronic musculoskeletal disorder (cMSD) appear to be highly prevalent in T2DM [5–10].

One will ask: is there a documental evidence of association between T2DM and chronic musculoskeletal pain (cMSP)? Despite the fact that both diabetes and cMSD complaints are relatively common, few studies have focused on the relationships between chronic musculoskeletal complaints and diabetes mellitus. To clarify this potential association, a cross-sectional study may be an effective beginning and will provide potential clues to the mechanism of chronicity of MSD among individuals with type 2 diabetes mellitus.

We therefore aim to investigate the prevalence of chronic pain in individuals with T2DM compared to their age-gender-physical activity-matched cohort to establish a possible association between chronic pain and T2DM in a cross-sectional survey.

Method

The research was reviewed and the protocol approved by the University of Nigeria Teaching Hospital Research Ethics Committee (NHREC/05/01/2008B-FWA0002458-

1RB00002323). Participants were recruited from the University of Nigeria Teaching Hospital and Enugu State University of Sciences and Technology Teaching Hospital as well as both universities and hospital communities. For the diabetes patients, this was done in the clinics on days when the patients were seeing their physicians. A patient who expressed interest in participating also completed an informed consent process which included authorization to review their medical record. Healthy cohorts were given a questionnaire at their offices or university quarters. To avoid the inclusion of persons with undiagnosed diabetes among the healthy cohorts, a random non-fasting glucose of ≥200 (mg/dL) [11.1 mmol/L] forms the exclusion criterion [11].

The International Physical Activity Questionnaire (IPAQ) was distributed to individuals who met the inclusion criteria and who consented to participating in the study. Participants' weights to the nearest 0.1 kg and heights to the nearest 1.0 cm were measured with weight and height scales respectively. A modified standardized Nordic questionnaire [12] was used to seek information about chronic musculoskeletal pain. Participants were asked whether they had suffered pain or stiffness in muscles and joints lasting for at least 3 months during the last year. Also, they were asked to indicate the number of days during the last month of such complaints. In this questionnaire, those participants who responded "yes" were then asked to tick off one or several of the following nine areas of the body: neck, shoulders, elbows, wrist/hands, upper back, low back, hips, knees, and/or ankles/feet.

Data analysis

All data analyses were performed using Statistical Package for the Social Sciences, version 15 (SPSS, Chicago, IL, USA). Personal characteristics of participants were presented in a table of frequencies and percentages. Physical activity in met-minute value was used to categorize individuals into low, moderate, and high physical activity. Differences in age and BMI of diabetics and non-diabetics were tested with an independent *t* test. Chi-square was employed to test the differences in the number of males and females, association between diabetes and musculoskeletal pain, as well as association between musculoskeletal pain and age, gender, and BMI. Adjusting for the appropriate covariate, odds for musculoskeletal discomfort in at least one body segment as well as the different body regions were sought by logistic regression using the backward stepwise model including all intercepts and defining subpopulations (musculoskeletal disorder) by factor (diabetic status) and covariates while considering only diabetes status for determining hierarchy (musculoskeletal disorder prevalence) within the covariate effect. In all inferential analyses, a 95 % confidence interval was assumed with the significant level set at $p < 0.05$.

Results

Four hundred questionnaires were given out. A total of 347 subjects (191 (55 %) female and 156 (45 %) male) of whom 167 (48.1 %) are diabetics and 180 (51.9 %) non-diabetics completed the questionnaire, with a response rate of 86.75 %. The age of the participants ranged between 35 and 90 years with means of 46.46 ± 9.21 and 59.23 ± 11.65 for those with and without diabetes respectively. Mean BMI were 26.54 ± 4.24 kg/m^2 for persons with diabetes and 26.54 ± 5.02 kg/m^2 for those without diabetes. The details of the demographic and anthropometric characteristics of the participants are presented in Tables 1 and 2.

Low back symptom was the most reported both by the diabetics (83; 49.7 %) and non diabetics (70; 38.9 %). There were no reports of elbow, wrist, and neck discomfort among the non-diabetics, and chronic elbow discomfort was the least reported among the diabetics. There was a significant association between diabetes and chronic musculoskeletal symptom prevalence in at least one body segment as well as in all the nine body regions studied (details presented in Table 3).

Table 4 demonstrated an association between age, BMI, gender, and chronic musculoskeletal symptoms. Age was significantly associated with chronic musculoskeletal symptom

Table 1 Personal characteristics of participants (n = 347)

	Number of participants	Percentage
Gender		
Male	191	55
Female	156	45
Age		
30–39	71	20.5
40–49	67	19.3
50–59	104	30.0
60–69	69	19.9
70–79	28	8.1
80–89	07	2.0
90–100	01	0.3
BMI		
Underweight	06	1.7
Normal weight	126	36.3
Overweight	148	42.7
Obese	67	19.3
Diabetes status		
Diabetic	167	48.1
Non-diabetic	180	51.9
Physical activity		
Low	109	31.41
Moderate	166	47.84
High	72	20.75

Table 2 Anthropometric characteristics between the diabetes and the non-diabetes groups (n = 347)

Anthropometric characteristics	Diabetics $x \pm SD$	Non-diabetics $x \pm SD$	t	p value
Age	46.46 ± 9.21	59.23 ± 11.65	−11.365	0.043
BMI	26.54 ± 4.24	26.74± 5.02	−0.374	0.393
Demographic characteristics	Diabetics n (%)	Non-diabetics n (%)	X^2	p value
Gender				
Male n (%)	74	82		
Female n (%)	93	98	0.054	0.830

prevalence in at least one body segment as well as in all the nine body regions. Also, BMI was associated with prevalence of chronic musculoskeletal symptoms at the shoulder and hip but not with an overall prevalence or prevalence in the seven body regions other than the shoulder and hip. Gender was not associated with prevalence of chronic musculoskeletal symptoms.

The relative risk estimates by logistic regression showed that individuals with diabetes had 2.5 odds of chronic musculoskeletal symptoms in at least one body part compared to those without. Similarly, with diabetes, individuals are more than 28 times at risk of chronic musculoskeletal symptoms of the knee, and are close to 29 times at risk of chronic upper back musculoskeletal symptoms compared to those without diabetes. Also, chronic low back discomfort was 1.5 times more likely among individuals with diabetes compared to those without diabetes.

Discussion

We studied a cohort of Nigerians to investigate the association between diabetes and MSD pain. A current documentary of the prevalence of diabetes in Nigeria put it at about 5.2 % [13]. Although the prevalence is lower compared to what is obtainable in other countries, the burden is potentially significant due to co-morbidities associated with diabetes including musculoskeletal problems. In this cross-sectional study, prevalence of chronic musculoskeletal symptoms was high for both the participants with diabetes and those without diabetes. Low back symptoms were the most commonly reported for both groups. The elbow was the least reported body region with symptoms among the diabetics whereas there was no report of neck, elbow, and wrist and ankle/foot symptoms among the non-diabetics. Our finding should be interpreted in perspective and may not generalize to other regions given that the differential epidemiology of diabetes and musculoskeletal complaint in our population compared to other regions may modulate the associations between T2DM and the final outcome in terms of musculoskeletal complaints. For instance, the prevalence of diabetes [13] and osteoarthritis [14] in Africa is lower compared to that of other regions of the world. Therefore, our report should be interpreted in terms of a region-specific picture and not a single summary evidence regarding the global picture. That notwithstanding, our finding, although described as a specific developing country scenario, can serve as a foundation for future research with the capacity for conducting cross-regional comparisons.

In the present study, T2DM was associated with an increased prevalence of chronic musculoskeletal symptoms in at least one body region as well as in all nine body regions, lending credence to previous reports of a possible relationship of diabetes to some forms of chronic pain syndromes. For instance, a higher prevalence of fibromyalgia has been reported among

Table 3 12 months prevalence of musculoskeletal symptoms and association with diabetes

Body segments	Normal group (n = 180)	Diabetic group (n = 167)	X^2	p value
At least one body segment, yes (%)	73 (45.6)	105 (62.9)	17.27	<0.001*
Neck, yes (%)	0.0 (0.0)	15 (9.0)	16.90	<0.001*
Shoulder, yes (%)	1 (0.6)	10 (6.0)	8.33	0.004*
Elbow, yes (%)	0 (0.0)	6 (3.4)	8.58	0.01*
Wrist, yes (%)	0 (0.0)	9 (5.4)	9.96	0.02*
Upper back, yes (%)	1 (0.6)	24 (14.4)	24.59	<0.001*
Lower back, yes (%)	70 (38.9)	83 (49.7)	3.93	0.047*
Hip, yes (%)	8 (4.4)	28 (16.8)	14.15	<0.001*
Knee, yes (%)	1 (0.6)	23 (13.77)	23.51	<0.001*
Ankle/foot, yes (%)	0 (0.0)	15 (9.0)	16.17	<0.001*

* Means that p is significant at 0.05

Table 4 Association between musculoskeletal discomfort and personal characteristics of participants

Body segment	X^2	p value
At least one body segment		
Age	30.71	<0.001*
BMI	5.921	0.116
Gender	0.182	0.67
Neck		
Age	15.06	0.02*
BMI	7.816	0.05
Gender	2.12	0.15
Shoulder		
Age	10.77	0.96
BMI	9.352	0.025*
Gender	0.001	0.97
Elbow		
Age	15.80	0.015*
BMI	4.066	0.254
Gender	1.975	0.160
Wrist		
Age	15.80	0.015*
BMI	4.110	0.250
Gender	0.504	0.478
Upper back		
Age	12.71	0.048*
BMI	0.852	0.837
Gender	2.421	0.120
Lower back		
Age	20.53	0.002*
BMI	3.932	0.269
Gender	0.193	0.661
Hip		
Age	23.32	<0.001*
BMI	11.512	0.009*
Gender	2.193	0.139
Knee		
Age	32.00	<0.001*
BMI	5.932	0.115
Gender	2.598	0.107
Ankle/foot		
Age	25.64	<0.001*
BMI	2.257	0.521
Gender	0.013	0.908

* Means that p is significant at 0.05

women with T2DM [15] as well as among 100 patients with diabetes compared to control [4]. Also, an Italian study demonstrated that majority of patients with DM reported chronic musculoskeletal symptoms [16]. Additionally, it has been previously reported by several studies that the hyperglycemic condition in DM is associated with reduced pain thresholds in individuals with known DM [17–19].

Among the most debated issues in the diabetes chronic musculoskeletal relationship is whether diabetes affects all musculoskeletal systems of the body equally irrespective of location. There are arguments that only musculoskeletal structures of the extremities are affected by diabetes, but studies have independently demonstrated that trunk muscle and other postural muscle control during a more strenuous task are hampered in those with T2DM [20–24]. Defective postural control may invariably create an abnormal musculoskeletal system biomechanics conducive for different musculoskeletal sequelae. This study seems to be the first that studied the occurrence of chronic musculoskeletal discomfort in T2DM, looking closer at different body regions. In particular, persons with T2DM were close to 29 times more likely to have chronic musculoskeletal symptoms at the upper back and knee, demonstrating that both centrally and peripherally located musculoskeletal structure may be affected equally.

Although the risk of chronic musculoskeletal disorder was not as high for other body regions as for the upper back and knee, our finding consistently showed that T2DM is associated with increased prevalence of chronic musculoskeletal symptoms and those with T2DM were at higher risk compared to those without. The strong association seen in this study raises a query if T2DM may in some manner mediate chronic musculoskeletal disorder. This research hypothesis needs to be answered by a prospective study.

Particularly, our finding seems to have put to rest the debate of selective association of type 2 diabetes to certain regional musculoskeletal symptoms and not others, and shows that T2DM may increase the risk of having centrally located musculoskeletal structures (e.g., upper back OR 28.9) much the same way as peripheral segments (e.g., knee OR 28.5). Also, all those with T2DM were consistently at higher risk of having chronic musculoskeletal symptom of the low back, shoulder, hip, knee, and foot/ankle compared to those without.

Limitations

Our study has several limitations. We did not investigate the blood sugar level of those with diabetes to understand differential interaction of control/uncontrolled diabetes to chronic musculoskeletal symptoms. Also, we could not estimate the relative risk of musculoskeletal symptoms at the neck, elbow, wrist, and ankle/foot due to the fact that there were no non-diabetic persons who reported symptoms at these regions. Future research should incorporate a larger sample so as to be able to draw a risk estimate of chronic musculoskeletal pain in these body regions. Finally, the cross-sectional design which was utilized in our study at best explained the association between T2DM and chronic musculoskeletal symptoms and does not infer a cause and effect relationship.

Conclusion

Individuals with type 2 diabetes are at increased risk of developing chronic musculoskeletal symptoms both for the centrally and peripherally located musculoskeletal regions. This is insightful because these chronic musculoskeletal pains may result in significant morbidity if overlooked in routine diabetes clinics, with further deterioration in quality of life and independence in activities of daily living among diabetics. As such, physicians and other clinicians managing diabetics should routinely inquire of patients regarding symptoms of musculoskeletal sequelae as well as monitor patients in order to timely intervene or appropriately refer patients for optimum care. Further study is warranted to investigate elements responsible for the increased risk/prevalence including somatic and psychological factors.

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Compliance with ethical standards All procedures performed in studies involving human participants were in accordance with the ethical standards of the University of Nigeria Teaching Hospital Ethics and Research Committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Conflict of interest The authors declare that they have no conflicts of interest.

Informed consent Written informed consent was obtained from all individual participants included in the study.

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