

ORIGINAL ARTICLE

Frequency and associated factors of upper limb musculoskeletal disorders (ULMSDs) among Bangladeshi diabetic population: A facility-based multicentered cross-sectional study

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Abstract

Background: Musculoskeletal complications are now being acknowledged as significant but overlooked complications of diabetes mellitus, leading to disability and poor quality of life. Yet, there is a scarcity of research on upper limb musculoskeletal disorders (ULMSDs) in diabetic patients in Bangladesh. **Aim:** Our study aims to assess the prevalence and risk factors of ULMSDs among Bangladeshi adults with diabetes. **Methods:** A multicenter, cross-sectional study was conducted among 363 adult diabetic patients from multiple health care facilities in Bangladesh. Information on socio-demographic and lifestyle-related factors, clinical profile, comorbidities, and common ULMSDs was gathered through face-to-face interviews and physical examination. Prevalence was calculated using descriptive statistics, and binary logistic regression analysis was conducted to examine the factors associated with ULMSDs. Odds ratios (ORs) and 95% confidence intervals were adjusted for result analysis. **Results:** The prevalence of ULMSDs was 57.6%. The most prevalent ULMSDs were diabetic hand syndrome (44.9%), adhesive capsulitis (38.8%), rotator cuff tendinitis (38.0%), and carpal tunnel syndrome (37.2%) respectively. Severe physical inactivity was significantly associated with ULMSDs ($p = 0.03$). Longer duration of diabetes (more than 10 years) was associated with an increased risk of ULMSDs ($p = 0.01$). Diabetic neuropathy (OR = 2.06, $p = 0.031$), diabetes control by lifestyle modification only (OR = 3.93, $p = 0.03$), and dyslipidemia ($p < 0.05$) were also significant predictors in our study. **Conclusion:** ULMSDs are common in Bangladeshi adults with diabetes. Periodic screening and holistic clinical and epidemiological approaches are needed to enhance the quality of life. **Relevance for patients:** Integrating upper limb musculoskeletal screening into diabetes care may improve function, reduce disability, and enhance quality of life.

Keywords: Diabetes mellitus; Musculoskeletal disorders; Upper limb; Bangladesh

1. Introduction

A well-known metabolic disease, diabetes mellitus (DM), is causing multiple global health issues and increasing the health care expenditure, lowering the quality of life, and causing death. The main issue in the management of diabetes is the treatment of diabetes complications.¹ Musculoskeletal complications have been linked with a range of micro- and macrovascular complications of diabetes and have been reported to occur in 36–75% of patients with diabetes in a study from Jordan.²

Musculoskeletal complications are generally not specific to DM and can be found in non-diabetic individuals as well. But they have been reported to be more prevalent in diabetic patients.³ Evidence suggests that hyperglycemia can stimulate non-enzymatic glycosylation and excessive collagen deposition in periarticular connective tissues that can affect the structural matrix and viscoelastic properties of the musculoskeletal system.⁴ Diabetic complications, such as connective tissue disorders, neuropathy, or micro- and macrovascular complications, may have a synergistic effect on the rapid development of musculoskeletal complications in DM.⁵ The most prevalent musculoskeletal disorders of the upper limb among diabetic patients are shoulder adhesive capsulitis (AC), carpal tunnel syndrome (CTS), Dupuytren's contracture (DC), trigger finger (TF), De Quervain's contracture (DQC), and limited joint mobility (LJM).^{6–8}

Diabetic hand syndrome (DHS) is a common clinical manifestation for diabetic patients and almost invariably affects long-standing diabetic patients having poor or suboptimal glycemic control and microvascular complications.^{9–11} In clinical practice, the hand may show some important pathological signs, and clinicians should be aware of these clues while diagnosing and assessing diabetes patients.¹² The term DHS was first coined by Jung *et al.*¹³ in 1971 to describe the flexion contractures of fingers and delays in nerve conduction of the median nerve.

Diabetic hand syndrome is defined by the presence of three conditions: First, LJM or diabetic chiroarthropathy,^{11,14,15} which is a common condition in diabetes patients with an incidence of 20–54%.^{15,16} Second, the TF or flexor tenosynovitis (FTS)^{17,18} with an incidence of 13–20%.^{15,17} Third, DC with an incidence of 14–26%,^{15,17,19,20} which are frequently combined and may be potentially disabling, especially for diabetic patients.

Another important musculoskeletal complication in

the diabetic population is entrapment neuropathy, and the most common type of entrapment neuropathy is CTS,²¹ which involves the combined area of hand, arm, and fingers and has sensory and motor symptoms.²² CTS is a group of symptoms and signs produced by entrapment of the median nerve within the carpal tunnel at the wrist, resulting in dysfunction and ischemia of the nerve.¹ The compression of the median nerve between the flexor tendons of the human hand is the crucial element for the CTS symptoms, such as paresthesia, numbness, and burning pain at night.²³ One study showed the prevalence of CTS in the general population is 2.1% in men and 3.0% in women.²⁴ While the origin and development of CTS is unknown, occupational diversity is associated with a higher incidence and prevalence of CTS.²³ The incidence and prevalence of CTS are increased in occupations related to high-pressure, high-force, repetitive, and vibrating tools.²³ CTS is also known to be associated with obesity, hypothyroidism, pregnancy, rheumatoid arthritis, and osteoarthritis.²³ Moreover, CTS is one of the significant musculoskeletal disorders associated with diabetes, along with shoulder capsulitis, DC, and stiff joints.²⁵

Several studies have been undertaken in recent years to explore the relationship between diabetes and CTS, with one study reporting that diabetes poses a risk for developing CTS.^{3,26–28} Other previous studies have also reported a possible link among glycosylated hemoglobin (HbA1c), duration of DM, microvascular complications, and CTS.^{29,30} The association between hand complications and both type 1 and 2 DM, as well as their relationship with microvascular complications, is well documented.^{19,24,31} Most earlier studies focused on the frequency of rheumatic complications of DM and were conducted in Western countries and, to some extent, in other countries. According to a study from Bangladesh, the prevalence of CTS among Bangladeshi diabetics is 27%.³² Another study from Bangladesh stated that the most frequent musculoskeletal disorders among the diabetes affected population are degenerative joint disease, inflammatory joint disease, spondylosis, and osteoarthritis.³³ However, there is scarce data from Bangladesh regarding the frequency and risk factors of upper limb musculoskeletal disorders (ULMSDs) among diabetic patients in Bangladesh. Therefore, the current study aims to determine the prevalence and associated factor of ULMSDs among Bangladeshi adults with diabetes. This includes assessing the prevalence of specific ULMSDs such as DHS, AC, rotator cuff tendinitis, and CTS, as well as determining lifestyle, clinical, and

metabolic variables. The study's design, as a facility-based, multi-centered, cross-sectional study, offers insights into the prevalence of musculoskeletal complications among patients across different health care facilities and geographical locations. The study includes socio-demographic, lifestyle, diabetes-related, and comorbidity factors, thus providing a comprehensive view of the risk factors for ULMSDs.

The general objectives of our study included:

- To assess the prevalence of ULMSDs among the diabetic population.
- To explore the relationship between ULMSDs and associated factors.

The specific objectives of our study included:

- To determine the prevalence of specific hand disorders, such as LJM, DC, CTS, and TF, DQC, and other musculoskeletal disorders such as shoulder AC and rotator cuff tendinitis.
- To utilize appropriate statistical methods to explore the association between hand musculoskeletal disorders and other musculoskeletal disorders of the upper extremity and diabetic-related factors.

The scope of this study also includes practical implications, underscoring the need for musculoskeletal screening and an integrated management approach in diabetes. By associating musculoskeletal conditions with disability and well-being, the results point to a lesser-known facet of diabetes in Bangladesh.

2. Materials and methods

A cross-sectional observational study was conducted among diabetic patients who presented to the diabetes-dedicated non-communicable disease (NCD) centers between June 2025 and November 2025. A total of 428 patients were invited to participate in the study after informed consent was obtained regarding the study's aims, potential benefits, and risks. Among them, 386 patients agreed to enroll in our study. Finally, information from 363 patients was analyzed in our study. A pre-structured questionnaire was developed covering socio-demographic, behavior-related, and physical activity-related factors, where test re-test reliability was performed by the experts before implementation of the questionnaire.

2.1. Study settings, duration, and population

The study was conducted at four medical college hospitals in Bangladesh: Dhaka Medical College, Chittagong Medical College, Mugda Medical College, and Khulna Medical College. The study was conducted over approximately six months, from June 2025 to November 2025. The study

population comprised individuals with DM who attended the dedicated diabetes NCD centers at the selected study sites for regular health check-ups during the study period.

2.2. Inclusion and exclusion criteria

To maintain consistency in participant selection and ensure that the study population was appropriate for the research objectives, specific inclusion and exclusion criteria were established prior to data collection. These criteria were designed to include adult individuals with diabetes mellitus who were suitable for evaluation of upper-limb musculoskeletal disorders. At the same time, participants with certain medical conditions or circumstances that might influence musculoskeletal manifestations or affect the assessment of the study outcomes were excluded. The criteria were applied uniformly across all participating study centers to ensure comparability of the study population.

The inclusion criteria included:

- Diabetic patients aged more than 18 years with informed written consent.
- Diabetic patients with musculoskeletal disorders affecting their hands as well as their upper extremities.

The exclusion criteria included:

- Diabetic patients with pregnancy.
- Diabetic patients with a history of trauma to the hands and upper arm.
- Diabetic patients with inflammatory diseases like rheumatoid arthritis, systemic lupus erythematosus, and osteoarthritis.
- Diabetic patients with thyroid disorders and exposed to alcoholism.
- Diabetic patients with other seropositive or seronegative arthropathy.
- Diabetic patients having neuro-inflammatory diseases like multiple sclerosis (MS).

2.3. Sampling method

The study utilized a systematic sampling technique (selecting every alternate participant who met the inclusion criteria, while considering the exclusion criteria).

2.3.1. Sampling procedure

After explaining the aim, purpose, and procedure of the study, participants attending the NCD corner dedicated to diabetes routine check-up centers who met the inclusion criteria and did not meet the exclusion criteria were selected as the study sample. In our study, every alternate participant was selected. This method helped in obtaining a sample that reflects the diversity of the diabetic population

in terms of age, gender, and other demographic factors. The systematic approach facilitated organized data collection, as researchers could follow a predetermined method for selecting participants, making it easier to manage and analyze the data. By using systematic sampling, we minimized selection bias, which can occur if only certain types of patients are included. Moreover, this method enabled us to gain a more comprehensive understanding of the prevalence of hand disorders across demographic groups within the diabetic population.

2.3.2. Sample size calculation

The study utilized the Rao soft calculator (2025, Raosoft, Inc., USA)³⁴ for sample size calculation, assuming a prevalence of hand disorders of 50% in the Bangladeshi diabetic population. The target sample for the study was 377. However, given the 15% non-response rate and participants withdrawing from the study before data collection following enrollment and consent, we collected 428 data points to ensure generalizable, representative findings.

2.4. Materials

The study utilized a pre-structured questionnaire, which was prepared with consideration of previous studies,^{1,2} the expert opinions and experiences of the physical medicine specialist and postgraduate physiotherapists. The tool contained socio-demographic, diabetes-related, behavior-related, and health-related information, as well as clinical information regarding musculoskeletal disorders of the hand and upper extremities.

2.5. Measurements of variables

2.5.1. Socio-demographic variables

The study collected socio-demographic information, including age, sex, education, residence, and occupation. Age was categorized into 18–30 years, 31–40 years, 41–50 years, 51–60 years, and >60 years. Education level was classified as primary or below, secondary, higher secondary, and university or above. Residence was grouped into village, town, and urban areas. Occupation was categorized as job, business, dependent, and others.

2.5.2. Behavior-related variables

The study collected information regarding the status of smoking, alcoholism, physical activity, and exposure to vibrating work of the individual. The physical activity level was measured using the International Physical Activity Questionnaire (IPAQ). The IPAQ scale is commonly used to assess physical activity levels.³⁵ It categorizes physical activity into three levels: low, moderate, and high intensity. It measures the amount of physical activity in terms of

frequency, duration, and intensity. The IPAQ is often used in research and health assessments to evaluate an individual's physical activity over a typical week. Briefly, based on an individual's responses, their physical activity level can be expressed continuously or categorized. This is typically expressed as metabolic equivalent of task (MET)-min per week: MET level $\times$ minutes of activity $\times$ events per week. To calculate MET minutes per week, the given MET value was multiplied by a specific constant for that domain; for example, walking = 3.3, moderate activity = 4, vigorous activity = 8. Then the physical activity level was categorized according to the weekly MET value into three categories. High physical activity was defined as more than 1,500 MET per week; moderate physical activity as 600–1,499 MET per week; and low physical activity as less than 600 MET per week.

2.5.3. Diabetes-related variables

The study collected information on the type and duration of diabetes, as well as macro- and microvascular complications, including coronary artery disease (CAD), cerebrovascular disease (CVD), peripheral vascular disease (PVD), diabetic retinopathy, diabetic neuropathy, and diabetic nephropathy. CAD, CVD, and PVD were determined by evaluating previous health records. Diabetic retinopathy was determined by ophthalmologic fundoscopic examination, and diabetic neuropathy was determined by Stokes and glove-type sensory loss, as well as loss of joint position and vibration sensation in the lower limbs. Data on FBS from the interview day or the immediate previous day were used; HbA1c data were collected from the health record book; and medication adherence was assessed using the four-item Morisky Green Levine Medication Adherence Scale (MGLS).³⁶ The composite four items in this adherence scale were: “Q1: Do you ever forget to take your diabetic medication?” “Q2: Do you ever have problems remembering to take your diabetic medication?” “Q3: When you feel better, do you sometimes stop taking your diabetic medication?” and “Q4: Sometimes if you feel worse when you take your diabetic medication, do you stop taking it?” Assessment of adherence to diabetic medications was based on patients' self-reported recall of using diabetic medications over the previous two weeks using MGLS. The degree of adherence was determined using the MGLS, calculated by counting all “yes” answers. In this scale, scores gained from the MGLS ranged from 0 to 4, and each of the four items was in a (yes/no) format. One point was assigned for each positive response (“yes”), while a score of 0 was assigned for each negative response (“no”). Because all four items were negatively coded, a lower total score indicated better medication adherence. A total score of 0 indicated

high adherence, a score of 1 or 2 indicated intermediate adherence, and a score of 3 or 4 indicated low adherence.³⁷ The questionnaire also collected information on diabetes management practices, including lifestyle modification, oral antidiabetic medication use, insulin therapy, or a combination of oral antidiabetic medications and insulin.

2.5.4. Health-related variables

The study collected information on hypertension and dyslipidemia status among diabetic individuals. The lipid profile, including total triglycerides, total cholesterol, low-density lipoprotein, and high-density lipoprotein, was documented during the interview. Body mass index (BMI) was calculated and documented in our data collection tool.

2.5.5. Musculoskeletal disorders

Hand complications (LJM, DC, TF, CTS, and thick skin) were evaluated by trained physicians (co-investigators of this study) who received adequate training from a rheumatologist before commencing the study. LJM was considered present if one or more interphalangeal or metacarpophalangeal joints failed to make contact when the patient was asked to oppose the palmar surfaces of the fingers in a praying position with the wrist maximally flexed (prayer sign).³⁸ DC was diagnosed if there was a palpable nodule along flexor tendons, tethering of the palmar or digital skin, a pre-tendinous band, or a digital flexion contracture,³⁹ and the TF or FTS was diagnosed if there was locking upon flexion or extension of any finger, or there was thickened flexor tendon over the metacarpophalangeal joint.⁴⁰ The CTS-6 evaluation tool was used to assess CTS, which was confirmed by the trained physicians. The CTS tool consists of two components: a symptoms and history section and a physical examination section, with a total possible score of 26 points. Patients with a total score > 12 and without comorbidities that could cause symptoms similar to those of CTS were considered positive for CTS.⁴¹

Other musculoskeletal disorders of the upper arm were also assessed in our study. AC of the shoulder was considered positive, with patients having more restricted shoulder movement (equal restriction of both passive and active movement) than normal in at least three planes (external rotation > abduction > internal rotation) or unilateral pain for more than a month, and inability to lie on the affected shoulder was diagnosed as AC of the shoulder.^{39,42} Similarly, rotator cuff tendinitis was considered positive with the presence of tenderness on the lateral side of the head of the humerus below the acromion. Active abduction of the arm induced severe pain, especially in the arc between 60° and 120°.⁴³ DQC was considered positive with the presence of pain and tenderness over the radial styloid with a positive Finkelstein maneuver.⁴⁴

2.6. Ethical consideration

The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki and relevant national guidelines. Ethical clearance was obtained from the Institutional Ethics Review Board of Mugda Medical College Hospital, Dhaka (Institutional Review Board number: MuMC/IERB/ECC/2025/93). Written informed consent was obtained from all participants prior to enrollment, and participants were assured of confidentiality, anonymity, and the right to withdraw from the study at any time without affecting their medical care. All data were securely stored and used exclusively for research purposes.

2.7. Data collection procedure

Following informed written consent after being informed about the detailed purpose, procedure, and aims of the study, a pre-structured questionnaire was administered to diabetic patients attending the selected centers for health screening check-ups during the dedicated study period who met the inclusion and exclusion criteria. The questionnaire was translated into Bangla during data collection, re-translated into English during data analysis, and test-retest reliability was carefully assessed during this transition. Before commencing data collection among a large-scale population, the questionnaire was tested for validity and reliability on a 5% sample of the target population. For this purpose, internal consistency and content validation index were calculated for each item of the pre-structured questionnaire. They demonstrated satisfactory performance, so the questionnaire was used to collect data from a large population, following consultation with the experts and principal investigators. A 1-day training session was conducted by the principal investigator for the co-investigators, aimed at data collection and understanding of clinical examinations for the diagnosis of musculoskeletal diseases. All co-investigators were registered physicians with at least one year of experience working with patients with musculoskeletal disorders. The questionnaire was checked for completeness and consistency daily by the principal investigator.

2.8. Data analysis

Data were checked, coded in Excel (2010, Microsoft Corporation, USA), and then entered into Statistical Package for Social Sciences (SPSS 25.0, IBM, United States) for analysis. Descriptive statistics such as percentages, frequencies, means, standard deviations, tables, and graphs were used to present the characteristics of the study participants. The binary logistic regression model was fitted to identify factors for ULMSDs among DM patients.

Then, the level of significance was declared based on the adjusted odds ratio (OR) with a 95% confidence interval (CI) at a p -value < 0.05 .

3. Results

A total of 363 participants were included in the study (Table 1). The largest proportion of participants was aged over 60 years (36.1%), followed by those aged 51–60 years (32.8%). Participants aged 41–50 years constituted 23.4%, while smaller proportions were aged 31–40 years (7.2%) and 18–30 years (0.6%). More than half of the participants were male (53.2%). Regarding educational status, 33.9% had attained university-level education or above, while 26.2% had primary education or below. Secondary and higher secondary education were reported by 20.9% and 19.0% of participants, respectively. A higher proportion of participants resided in villages (43.8%), followed by urban or sub-city areas (34.4%) and cities (21.5%). More than half of the participants were dependent on family members (52.1%), while 22.0% were employed, 14.9% were engaged in business, and 11.0% were categorized as others.

Behavioral characteristics are summarized in Table 2. Smoking was reported by 21.2% of participants, whereas alcohol consumption was uncommon (0.3%). Most participants reported severe physical activity (95.6%), with only 2.8% and 1.7% reporting moderate and mild physical activity, respectively. Exposure to vibration was reported by 5.0% of participants.

Diabetes-related characteristics are presented in Table 3. Over half of the participants (57.0%) had a diabetes duration of less than 10 years. Diabetic neuropathy was present in 41.0% of participants, diabetic nephropathy in 22.3%, and diabetic retinopathy in 30.0%; however, nearly half of the participants (49.6%) had not undergone retinopathy screening. Regarding diabetes management, 44.1% were treated with oral hypoglycemic agents, 27.8% with insulin, 21.5% with a combination of both, and 6.6% with lifestyle modification alone. Medication adherence was high in 32.2% of participants, intermediate in 28.4%, and low in 39.4%. The mean fasting blood sugar level was 10.14 ± 3.69 mmol/L, and the mean HbA1c level was $6.53 \pm 3.83\%$.

As shown in Table 4, CAD was present in 28.4% of participants, peripheral artery disease in 14.6%, and CVD in 38.3%. Hypertension was highly prevalent (73.3%), while dyslipidemia was reported in 30.9% of participants. The mean body mass index was 23.8 ± 2.94 kg/m².

Overall, 57.6% of participants had ULMSDs (Figure 1). DHS was the most common condition (44.9%), followed by AC (38.8%), rotator cuff tendinitis (38.0%), and CTS

(37.2%). DQC was the least frequent disorder (16.7%) (Figure 2) in our study.

Table 1. Socio-demographic characteristics of participants

Variables	Category	n (%)
Age (years)	18–30	2 (0.6)
	31–40	26 (7.2)
	41–50	85 (23.4)
	51–60	119 (32.8)
	More than 60	131 (36.1)
Sex (missing data = 2)	Male	193 (53.2)
	Female	168 (46.3)
Education	Primary or below	95 (26.2)
	Secondary	76 (20.9)
	Higher secondary	69 (19.0)
	University or above	123 (33.9)
Residence (missing data = 1)	Village	159 (43.8)
	City	78 (21.5)
	Urban/sub-city	125 (34.4)
Occupation	Job	80 (22.0)
	Business	54 (14.9)
	Dependent on family	189 (52.1)
	Others	40 (11.0)

Table 2. Behavioral pattern of participants

Variables	Category	n (%)
Smoking (missing data = 1)	Yes	77 (21.2)
	No	285 (78.5)
Alcoholism	Yes	1 (0.3)
	No	362 (99.7)
	Mild	6 (1.7)
Physical activity	Moderate	10 (2.8)
	Severe	347 (95.6)
Exposure to vibration	Yes	18 (5.0)
	No	345 (95.0)

Table 3. Diabetes-related information of the participants

Variables	Category	n (%)
DM duration (missing data = 1)	<10 years	207 (57.0%)
	≥10 years	155 (42.7%)
DM neuropathy (missing data = 1)	Yes	149 (41.0%)
	No	213 (58.7%)
DM nephropathy	Yes	81 (22.3%)
	No	282 (77.7%)
	Yes	109 (30.0%)
DM retinopathy	No	74 (20.4%)
	Did not check	180 (49.6%)
	Oral drugs	160 (44.1%)
DM management	Insulin	101 (27.8%)
	A combination of two	78 (21.5%)
	Lifestyle modification	24 (6.6%)
	High	117 (32.2%)
Medication adherence	Intermediate	103 (28.4%)
	Low	143 (39.4%)
Lab values		Mean ± SD
FBS (missing data = 5)		10.14 ± 3.69
HbA1c (missing data = 97)		6.53 ± 3.83

Abbreviations: DM: Diabetes mellitus; FBS: Fasting blood sugar; HbA1c: Glycosylated hemoglobin; SD: Standard deviation.

Table 4. Diabetic complications and other health-related variables of the studied participants

Variables	Category	n (%)
Coronary artery disease (CAD)	Yes	103 (28.4%)
	No	260 (71.6%)
Peripheral artery disease (PAD)	Yes	53 (14.6%)
	No	310 (85.4%)
Cerebrovascular disease (CVD) (missing data = 5)	Yes	134 (38.3%)
	No	224 (61.7%)
Hypertension (HTN)	Yes	266 (73.3%)
	No	97 (26.7%)
Dyslipidemia	Yes	112 (30.9%)
	No	251 (69.1%)
Body mass index (kg/m ² , mean ± standard deviation)		23.8 ± 2.94

Binary logistic regression analysis was performed to identify factors associated with ULMSDs, where the model fitting status was satisfactory (Table 5). Severe physical inactivity was significantly associated with musculoskeletal disorders ($p = 0.03$). Participants with a diabetes duration of 10 years or longer had significantly higher odds of musculoskeletal disorders compared to those with shorter disease duration ($p = 0.01$). Diabetic neuropathy was also a significant predictor ($B = 0.724$, $p = 0.031$);

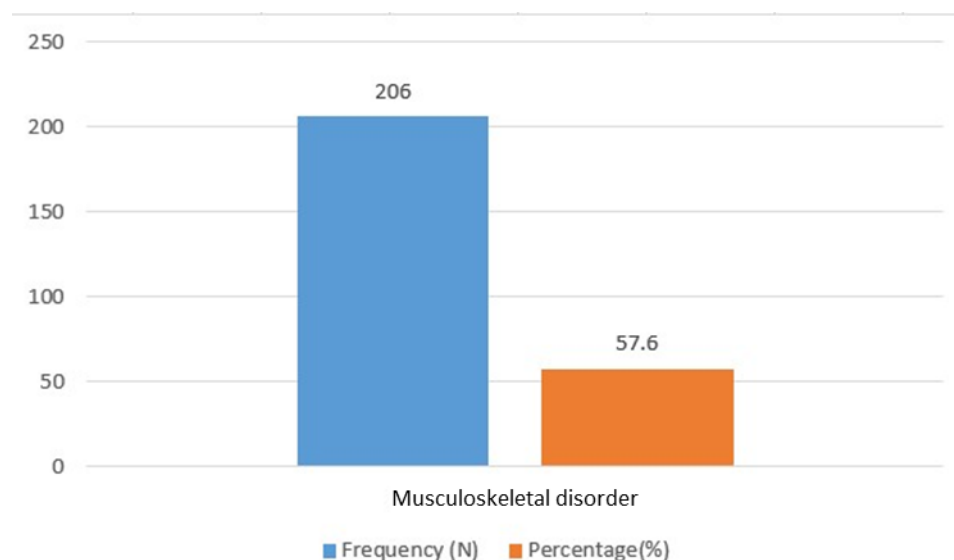


Figure 1. Prevalence of upper limb musculoskeletal disorders of the participants

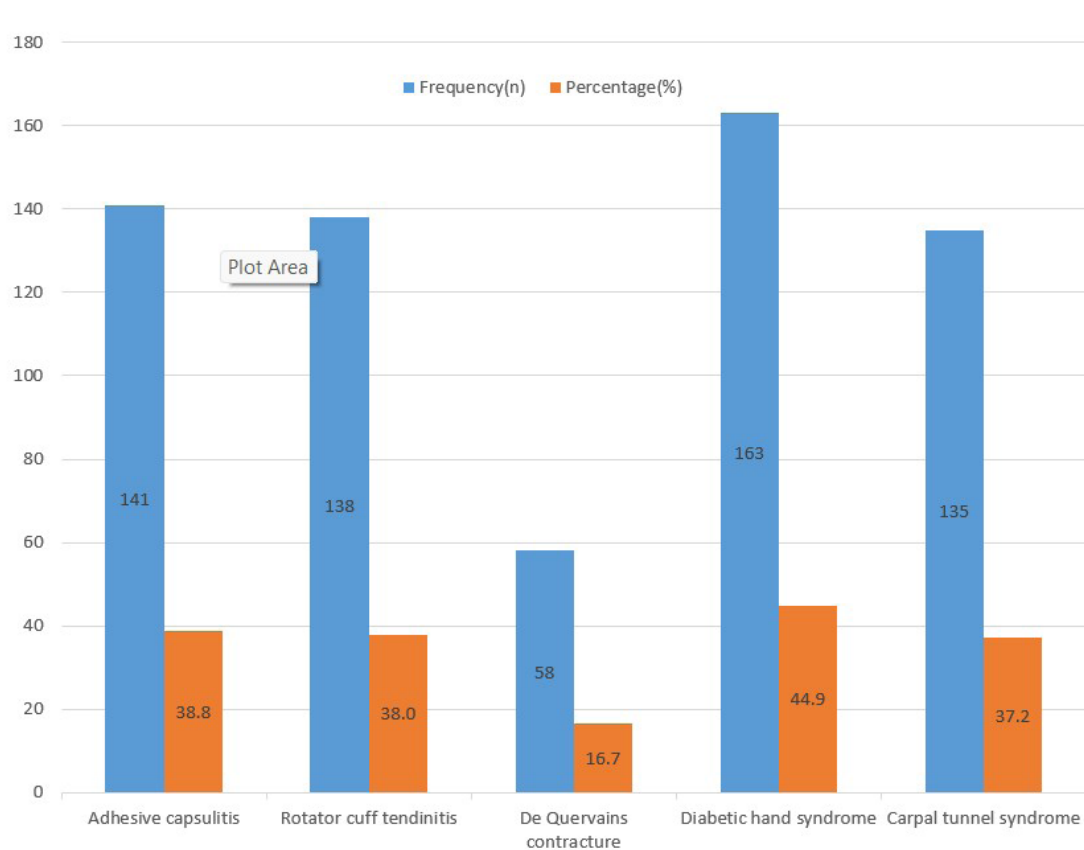


Figure 2. Types of different upper limb musculoskeletal disorders of the participants

participants with diabetic neuropathy had approximately twofold higher odds of musculoskeletal disorders (OR = 2.06) than those without this complication. Additionally, participants managed with lifestyle modification alone had higher odds of musculoskeletal disorders compared to those receiving oral hypoglycemic agents ($p = 0.03$; OR = 3.93). Dyslipidemia was significantly associated with musculoskeletal disorders ($p < 0.05$) among the studied population.

4. Discussion

We investigated the prevalence and risk factors for ULMSDs in patients with DM. A high proportion of the subjects (57.6%) had at least one type of ULMSD, suggesting a considerable burden of musculoskeletal complications in patients with diabetes. These results are in line with other research showing a greater frequency of musculoskeletal disorders among patients with diabetes compared with the general population, which may be attributed to prolonged exposure to high glucose levels, affecting connective tissues and microvascular structures.^{45,46}

Table 5. Predictors of upper limb musculoskeletal disorders among diabetes patients

Variables	B	SE	Wald	df	p	OR
Age (years)						
18–30						
31–40	–21.040	4.010	0.000	1	1.000	0.000
41–50	–0.410	0.634	0.433	1	0.511	0.650
51–60	0.010	0.435	0.001	1	0.981	1.011
>60	0.279	0.356	0.615	1	0.433	1.322
Sex						
Male						
Female	1.8	4.020	0.000	1	1.000	1.200
Residence						
Village						
City	–1.9	4.010	0.000	1	1.000	0.000
Urban	–1.8	4.010	0.000	1	1.000	0.000

(cont'd...)

Table 5. (Continued)

Variables	B	SE	Wald	df	p	OR
Smoking						
No						
Yes	0.670	0.382	3.060	1	0.080	1.950
Alcoholism						
No						
Yes	-1.9.	4.000	0.000	1	1.000	0.000
Exposure to vibration						
Yes						
No	0.317	0.648	0.239	1	0.625	1.373
Physical activity						
Mild						
Moderate	2.140	1.360	2.450	1	0.110	8.490
Severe	-0.070	0.870	0.008	1	0.030	2.900
DM duration						
<10 years						
≥10 years	-0.413	0.312	1.747	1	0.010	6.620
Diabetic neuropathy						
No						
Yes	0.724	0.335	4.660	1	0.031	2.062
Diabetic retinopathy						
No						
Yes	0.184	0.345	0.285	1	0.593	1.200
Diabetes nephropathy						
No						
Yes	0.040	0.343	0.014	1	0.907	1.040
Diabetes management						
Oral drugs						

(cont'd...)

Table 5. (Continued)

Variables	B	SE	Wald	df	p	OR
Insulin	0.630	0.568	1.228	1	0.268	1.877
A combination of both	0.434	0.597	0.529	1	0.467	1.544
Lifestyle modification	1.370	0.664	4.254	1	0.030	3.934
Medication adherence score						
High						
Intermediate	-0.447	0.336	1.773	1	0.183	0.639
Low	-0.145	0.332	0.191	1	0.662	0.865
HTN						
No						
Yes	0.473	0.312	2.170	1	0.141	1.604
Dyslipidemia						
No						
Yes	0.220	0.311	0.501	1	0.038	1.246
CAD						
No						
Yes	0.518	0.321	2.600	1	0.107	1.679
PAD						
No						
Yes	0.003	0.432	0.000	1	0.994	0.997
CVD						
No						
Yes	-0.180	0.330	0.294	1	0.588	0.835

Abbreviations: CAD: Coronary artery disease; CVD: Cerebrovascular disease; DM: Diabetes mellitus; HTN: Hypertension; OR: Odds ratio; PAD: Peripheral artery disease; SE: Standard error.

In the current study, DHS was the most prevalent condition, followed by AC, rotator cuff tendinitis, and CTS. This is in line with previous studies that have reported DHS and AC as frequent conditions among diabetic patients with long duration of disease.^{31,47} Higher incidence of these conditions might be explained by the non-enzymatic glycosylation of collagen, which results in increased stiffness, loss of flexibility of periarticular tissues, and thickened connective tissue structures.

Severe physical inactivity was significantly associated with musculoskeletal disorders. This is consistent with the literature showing that low physical activity is associated with joint stiffening, muscle weakness, and LJM, which may lead to musculoskeletal disorders.⁴⁸ Furthermore, people with diabetes may avoid physical activity due to pain, fear of hypoglycemia, or other health complications and comorbidities, which can increase the risk of musculoskeletal disorders.

Our findings also showed that individuals with a diabetes duration of 10 years or longer had greater odds of musculoskeletal disorders. This result is supported by a number of studies that found increased musculoskeletal complications among participants with longer durations of diabetes.^{31,47} A potential reason may be that individuals with longer diabetes duration may experience the cumulative effects of prolonged hyperglycemia, which can alter connective tissue properties, decrease joint mobility, and cause stiffness. Furthermore, chronic complications of diabetes, including neuropathy and microvascular changes, might affect tissue repair and biomechanics, contributing to musculoskeletal complications.

Participants with diabetic neuropathy had significantly higher odds of musculoskeletal disorders than those without neuropathy. This positive association is biologically plausible, as diabetic neuropathy contributes to biomechanical alterations, impaired proprioception, muscle weakness, and loss of protective sensation, all of which increase susceptibility to musculoskeletal disorders. These findings are consistent with previous studies reporting that diabetic neuropathy is an important associated factor for the development of musculoskeletal complications in individuals with diabetes.^{31,49,50}

Patients who were managed with lifestyle modification only had a greater risk of developing musculoskeletal complications than those managed with oral hypoglycemic drugs. This could be due to poor glycemic control in patients treated with lifestyle intervention alone, especially if they fail to comply with the recommended physical activity and dietary advice. Impaired glucose control has been strongly associated with collagen deposition, fibrosis, and musculoskeletal disorders.⁴⁶

Dyslipidemia was also found to be associated with musculoskeletal disorders. Dyslipidemia is known to induce systemic inflammation and endothelial dysfunction, which can affect blood flow to the musculoskeletal system and result in degenerative changes.⁵⁰ Our results are consistent with another study showing an association between metabolic syndrome and musculoskeletal disorders.⁵¹

While hypertension, cardiovascular disease, age, sex,

smoking, alcohol intake, and obesity were common in our participants, these factors were not significantly associated with musculoskeletal disorders in the multivariable model in our study. This might indicate that metabolic factors may be more important in the development of ULMSDs than age, sex, and smoking status.

Multiple pieces of evidence also demonstrate that among diabetic patients, musculoskeletal disorders, including ULMSDs, are associated with various factors such as age and sex of the patient, lack of formal education, impaired metabolic control, duration of the disease, and the existence of microvascular complications, including neuropathy.^{52,53} Several personal and occupational factors are associated with musculoskeletal disorders (MSDs).⁵³ According to other evidence, metabolic disturbances such as increased protein glycosylation, decreased collagen degradation, microangiopathy, and neuropathy are all associated with MSDs.⁵⁴ A cross-sectional study from Bangladesh also demonstrated the relationship between smoking and MSDs among diabetic patients.⁵⁵ Chen *et al.*⁵⁶ stated that alcohol consumption is associated with MSDs, musculoskeletal pain, and burnout. The longer the duration of diabetes, the greater the chance of developing micro and macrovascular complications.⁵⁷ There is a certain relationship between MSDs and DM,⁵⁸ and therefore, it is essential to assess the diabetes control measures and medication adherence status for a better understanding of this relationship.

Based on this previous evidence, the variables included in this study were selected for their reported associations with musculoskeletal disorders among individuals with diabetes. Accordingly, we evaluated the associations of age, sex, education, smoking, alcohol consumption, physical activity, occupational vibration exposure, duration of diabetes, microvascular and macrovascular complications, diabetes control measures, medication adherence, dyslipidemia, and BMI with ULMSDs in our study population. However, given the cross-sectional design, the observed associations were not interpreted as causal.

4.1. Strengths of the study

The high rate of ULMSDs observed in this study underscores the importance of incorporating musculoskeletal examination into the management of diabetes. Early detection and treatment of musculoskeletal complications, encouragement of physical activity, and good glycemic control might enhance the quality of life and mitigate disability in diabetics.

4.2. Limitations of the study

While the study offers important insights into the burden

and risk factors of ULMSDs in Bangladeshi diabetic patients, it has several limitations. First, the cross-sectional nature of the study prevents causal inferences from being drawn between the factors and the ULMSDs. Second, certain risk factors (behavioral and lifestyle) were assessed using self-reported measures, which may be prone to recall and social desirability bias. Third, while the study covered several health care institutions, the sample might not represent all patients with diabetes in Bangladesh, thereby reducing the study's external validity. Fourth, the diagnoses of musculoskeletal disorders were primarily based on clinical examination and did not involve advanced imaging tools, which may lead to underdiagnosis or misdiagnosis of certain disorders. Finally, some possible confounding factors, such as exposure to repetitive handwork and ergonomic issues, were not fully investigated. Longitudinal and multicenter studies with objective measures of MSDs and larger sample sizes are needed to address these issues. Our urban hospital-based study population may have contributed to the high prevalence of physical inactivity and limited the generalizability of the findings. Another important limitation of our study is the exclusion of patients with osteoarthritis, rheumatoid arthritis, and other rheumatologic conditions. Although these criteria were applied to reduce potential confounding, they may have led to an underestimation of the true prevalence of musculoskeletal disorders and limited the generalizability of the findings to the broader population. Future studies should provide a more comprehensive estimate of the musculoskeletal disease burden and enhance the external validity of the findings in this vulnerable cohort. While diagnosing MSDs, inter-rater reliability was not formally assessed; however, all musculoskeletal examinations were conducted by experienced registered physicians using standardized clinical diagnostic methods.

5. Conclusion

Upper limb musculoskeletal disorders play a significant role in Bangladeshi DM patients, with a prevalence of over 50%. The most common lesions were DHS, AC, rotator cuff tendinitis, and CTS, demonstrating the substantial impact of musculoskeletal complications on function in this group. The study highlighted a number of important factors, including severe physical inactivity, diabetes-specific factors, including a long duration of the disease and presence of neuropathy, dyslipidemia, and the use of lifestyle modification only for managing diabetes.

The study underscores the complex nature of ULMSDs, revealing the interplay of metabolic, lifestyle, and diabetes-specific factors. Regular musculoskeletal assessment should be part of diabetes management, with specific interventions such as physiotherapy, exercise programs,

and effective management of diabetes and dyslipidemia. Modifying these risk factors can reduce disability, enhance quality of life, and prevent the progression of musculoskeletal complications in diabetes.

Our study shows a high burden of ULMSDs among Bangladeshi diabetic patients and reveals the main risk factors, such as physical inactivity, diabetes-specific factors, and metabolic dysfunctions. The study has significant implications for clinical care, public health strategies, and research:

- (i) Clinical practice: ULMSDs should be screened for regularly in the care of people with diabetes, especially those who are physically inactive, have diabetes-related complications, or have dyslipidemia or poor glycemic control. Early detection and treatment of musculoskeletal complications can lead to improved function, reduced pain, and better quality of life.
- (ii) Exercise and rehabilitation strategies: The strong link between physical inactivity and ULMSDs highlights the importance of exercise programs and physiotherapy programs that can be adapted to patients with diabetes. Promoting physical activity may prevent or delay the development of musculoskeletal complications.
- (iii) Health policy and planning: The prevalence of ULMSDs in the diabetic population suggests the need for health policies that include musculoskeletal evaluation in the management of diabetes. Allocating resources to rehabilitation, occupational therapy, and patient education may reduce the functional and economic burden of the complications.
- (iv) Research implications: The study highlights research gaps, such as the association between short-term duration of diabetes and ULMSDs, and the effect of lifestyle-only management on musculoskeletal complications. Prospective cohort and interventional studies are needed to determine whether a causal link exists and to assess the impact of specific preventive interventions.
- (v) Public health education: Educating the public and healthcare professionals about the risk and consequences of musculoskeletal complications in the upper limbs among diabetic patients can sensitize them towards early diagnosis, intervention, and prevention.

In conclusion, this study underscores the need to integrate musculoskeletal health screening into diabetes management, with interventions that focus on both disease control and physical activity to prevent ULMSDs among the Bangladeshi population with diabetes.

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Conflict of interest

The authors declare they have no competing interests.

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Ethics approval and consent to participate

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Ethical approval for the study was obtained from the Institutional Ethics Review Board of Mugda Medical College (Approval No: MuMC/IERB/ECC/2025/93). Permission was also obtained from the respective study centers prior to data collection. Written informed consent was obtained from all participants before enrollment in the study. Confidentiality and anonymity of the participants were strictly maintained throughout the research process.

Consent for publication

Informed written consent was obtained from the participants.

Availability of data

Data are available from the corresponding author upon reasonable request.

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