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Assessment of Foot and Ankle Musculoskeletal Complications in Diabetic Patients: A Cross-Sectional Analysis

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ABSTRACT

Diabetes mellitus is a chronic metabolic disorder associated with systemic complications, including musculoskeletal abnormalities affecting the foot and ankle. These complications can lead to gait disturbances, altered plantar pressure distribution, increased risk of ulceration, and functional limitations that reduce quality of life. The present study aimed to examine foot and ankle musculoskeletal abnormalities among diabetic patients and explore their relationship with neuropathy and duration of diabetes. A cross-sectional analytical study was conducted among diabetic patients attending tertiary care hospitals in Peshawar, Pakistan. Using convenience sampling, 120 individuals diagnosed with Type 1 or Type 2 diabetes mellitus were recruited. Musculoskeletal assessment included measurement of ankle range of motion using a universal goniometer, evaluation of foot posture using the Foot Posture Index-6, pain assessment with the Numeric Pain Rating Scale, and neuropathy screening using the Michigan Neuropathy Screening Instrument. Data were analyzed using descriptive and inferential statistics with SPSS version 26. The results demonstrated reduced ankle range of motion among participants, with mean dorsiflexion of 14.2° (SD = 4.3) and plantarflexion of 36.8° (SD = 6.1). Neuropathy showed a significant association with foot deformities ($\chi^2 = 8.72$, $p = 0.003$), particularly hallux valgus and claw toe deformities. Neuropathy scores were moderately correlated with pain intensity ($r = 0.51$, $p < 0.001$), while duration of diabetes showed a negative correlation with ankle range of motion ($r = -0.42$, $p = 0.001$). These findings highlight the importance of early musculoskeletal screening and physiotherapy interventions in diabetic care to prevent foot complications.

***Keywords:** Ankle range of motion, diabetes mellitus, diabetic neuropathy, foot deformities, plantar pressure.*

Introduction

Diabetes mellitus (DM) is an ongoing metabolic illness marked by constant hyperglycemia brought on by insulin production, insulin activity, or combined. Having diabetes' worldwide impact has grown dramatically in recent decades, particularly in low and middle-income nations where swift industrialization and lifestyle changes have helped to raise prevalence levels [4].

Genetic vulnerability, inactive lifestyle, dietary changes, and lack of preventative medical infrastructure all contribute to Pakistan's already high prevalence of diabetes. The rising prevalence of diabetes in the nation poses a major obstacle for the healthcare system and raises risk for many long term problems [1].

Traditionally, diabetic issues have been categorized as macrovascular illnesses such as cardiovascular ailment and tangential arterial illness and microvascular impediments such as neuropathy, nephropathy, as well as retinopathy. These issues are widely investigated as they are attached with demise and morbidity [6].

However, musculoskeletal issues have recently become acknowledged as major causes of functional disability in diabetes patients. Although they affect mobility and quality of life, these consequences are frequently ignored in conventional diabetic evaluation [3].

Among the musculoskeletal issues, especially significant are those affecting the foot and ankle complex since these structures are essential for weight bearing, balance, and gait mechanics. Any structural or functional damage in this area could greatly impact daily activities and mobility [8].

The end products of advanced glycation (AGEs) develop from persistent hyperglycemia; these promote collagen bounding and reduce tissue flexibility. One of the outcomes of this process is tendon and joint capsule stiffness, which ultimately reduces joint motion [8]. Compensatory gait patterns and higher forefoot loading, both of which raise the risk of diabetic foot ulceration, have been linked to decreased ankle dorsiflexion [7].

Musculoskeletal issues of the foot and ankle are sometimes underdiagnosed despite their clinical significance, especially in poor nations where diabetic screening campaigns concentrate mostly on vascular problems. Few regional statistics on the incidence of these problems among Pakistan's diabetic population exist [4].

Consequently, this research sought to determine the incidence of foot and ankle musculoskeletal problems in diabetic patients and appraise their link with neuropathy, pain severity, and duration of diabetes [9].

In order to prevent further damage and reduce the likelihood of serious effects, such as amputations as well as foot ulcers, immediate diagnosis of foot as well as ankle musculoskeletal problems within diabetes individuals is essential [10]. Clinically scrutinizing joint motion, foot anomalies as well as discomfort permits medical experts to categorize individuals that face a higher menace and immediately adopt protective measures such as client tutoring, physiotherapy, as well as suitable footwear options. Knowing the occurrence and patterns of this turmoil within the society might help physicians and politicians advance diabetic treatment standards and build up tailored rehabilitation initiatives [5].

Objectives of the Study

The objectives of this review were to:

1. To ascertain the frequency of musculoskeletal issues with the feet and ankles in individuals with diabetes mellitus.
2. To evaluate the relationship among diabetic peripheral neuropathy and foot and ankle musculoskeletal issues [9].
3. To assess the connection between diabetes patients' foot and ankle musculoskeletal problems and their level of discomfort.
4. To investigate the relationship between the incidence of foot and ankle musculoskeletal issues and the length of diabetes mellitus [4].

Materials and Methods

Study Design Criteria

This study employed a cross-sectional analytical design to assess the prevalence of foot and ankle musculoskeletal complications among diabetic patients and their association with neuropathy, pain intensity, and duration of diabetes [3].

Study Setting

The research was carried out in tertiary care hospitals' diabetic clinics, endocrinology outpatient departments, and physiotherapy rehabilitation facilities in Peshawar, Pakistan [1].

Sample Size

Using a 95% confidence interval and prevalence estimates (P = 0.40), the required sample size was determined to be 150 participants [4].

Sampling Technique

Convenience sampling was used to recruit eligible participants [6].

Inclusion Criteria

Individuals were added if they met the criteria:

- Had a confirmed diagnosis of Type 1 or Type 2 diabetes mellitus.
- Were aged between 30 and 70 years [5].
- Had a diabetes duration of at least five years [1].

Exclusion Criteria

Participants were excluded if they had:

- Recent fractures or lower limb surgery.
- Rheumatoid arthritis or other systemic musculoskeletal disorders [6].
- Neurological conditions unrelated to diabetes.
- Severe peripheral arterial disease [3].

Data Collection Tools

Data were collected using validated and standardized instruments:

- **Universal Goniometer**
  To measure ankle range of motion (dorsiflexion, plantarflexion, inversion, eversion).
- **Foot Posture Index (FPI-6)**
  To assess structural foot alignment and deformities [9].
- **Numeric Pain Rating Scale (NPRS)**
  To quantify pain intensity.
- **Michigan Neuropathy Screening Instrument (MNSI)**
  To detect peripheral neuropathy [7].

Statistical Analysis

- Descriptive statistics summarized demographic and clinical characteristics.
- Chi-square tests evaluated associations between neuropathy and foot deformities.
- Pearson correlation analyzed relationships between diabetes duration, pain intensity, and ankle mobility [8].
- Independent t-tests and ANOVA compared ankle range of motion across groups with different neuropathy and deformity profiles.

Statistical significance was set at $p \leq 0.05$ [6].

Strobe Flow Diagram (Study Participants)

Patients evaluated for eligibility
(n = 150)
↓
Excluded (don't meet the inclusion criteria or declined participation/fall in exclusion criteria)
(n = 30)
↓
Participants taken within this research
(n = 120)
↓
Fulfilled musculoskeletal assessment and tests
(n = 120)
↓
Data included in final statistical analysis (n = 120) [6].

Results

SPSS edition 21 was used to investigate the statistics. Table 1 suggests the demographic composition of the contestants, which discloses that males made up the bulk of the responders (56.7 percent), but, females accounted for 43.3 percent. The majority of responders (31.7%) were between the ages of 51 and 60. About the kind of diabetes, 76.7% of the respondents had Type II diabetes; while, 23.3 percent had Type I diabetes [1].

Table 2 shows how often diabetic persons have foot as well as ankle musculoskeletal problems. According to the results, 46% of patients experienced restricted ankle dorsiflexion (<15°), followed by claw toes (18%), hallux valgus (15%), hammer toes (12%), and restricted plantarflexion (<30%) in 8% of the sample [3].

Additionally, Table 3 shows the mean ankle ROM of participants. The mean dorsiflexion was 14.2° (SD = 4.3), plantarflexion was 36.8° (SD = 6.1), inversion was 21.4° (SD = 5.2), and eversion was 11.6° (SD = 3.4), suggesting variations in ankle mobility among people with diabetes [7].

Table 4 shows the chi-square test's link between neuropathy and foot abnormalities. While no link was found with hammer toes (p=0.078), the analysis showed a statistically significant link between neuropathy and the presence of any foot deformity (p = 0.003), hallux valgus (p = 0.011), and claw toes (p = 0.020) [2].

Table 5 further shows the correlational study of important parameters. Duration of diabetes as well as dorsiflexion ROM illustrated a mild negative correlation (r = - 0.42, p = 0.001), indicating that longer diabetes is related with lower ankle mobility. Furthermore, significant positive connections were found between neuropathy score and pain intensity (r = 0.51, p < 0.001), BMI and foot deformity severity (r = 0.33, p = 0.004), and duration of diabetes and foot deformity severity (r = 0.35, p = 0.003), hence implying that diabetic patients with higher BMI and longer diabetes experience more discomfort and foot deformity [5].

Table 1: Demographic features of participants

Variable	Frequency (%)
Male	68 (56.7)
Female	52 (43.3)
Total	120
Categories Of Age	
30 - 40	22 (18.3)
41 - 50	36 (30.0)
51 - 60	38 (31.7)
> 60	24 (20.0)
Total	120
Type Of Diabetes	
Type 1	28 (23.3)
Type 2	92 (76.7)
Total	120

Table 2: Prevalence of foot as well as ankle musculoskeletal complications

Complication	Frequency (%)
Limited dorsiflexion (< 15°)	55 (46)
Hallux valgus	18 (15)
Claw toes	22 (18)
Hammer toes	15 (12)
Limited plantarflexion (< 30°)	10 (8)

Table 3: Mean Ankle Range of Motion (ROM)

Movement	Mean ± S.D
Dorsiflexion	14.2 ± 4.3
Plantarflexion	36.8 ± 6.1
Inversion	21.4 ± 5.2
Eversion	11.6 ± 3.4

Table 4: Association Between Neuropathy and Deformities (Chi-Square Analysis)

Foot Deformity	Chi-Square (χ^2)	p-value
Any foot deformity	8.72	0.003
Hallux valgus	6.41	0.011
Claw toes	5.38	0.020
Hammer toes	3.12	0.078

Note: Significance set at p < 0.05

Table 5: Correlation Analysis of Key Variables

Variables	r	p-value	Direction/Interpretation
Duration of diabetes vs Dorsiflexion ROM	-0.42	0.001	Longer diabetes → reduced ROM
Neuropathy score vs Pain intensity	0.51	<0.001	Higher neuropathy → more pain
BMI vs Foot deformity severity	0.33	0.004	Higher BMI → more severe deformities
Duration of diabetes vs Foot deformity severity	0.35	0.003	Longer diabetes → more deformities

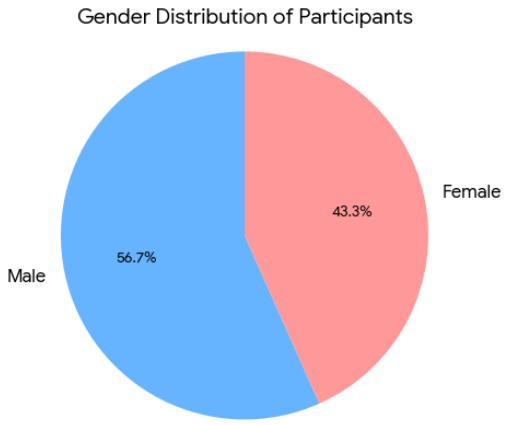

Figure 1. *Gender Distribution of Participants*

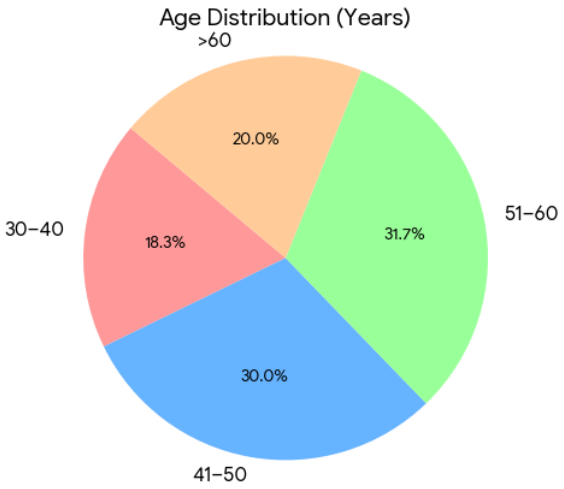

Figure 2. *Age Distribution of Participants (Years)*

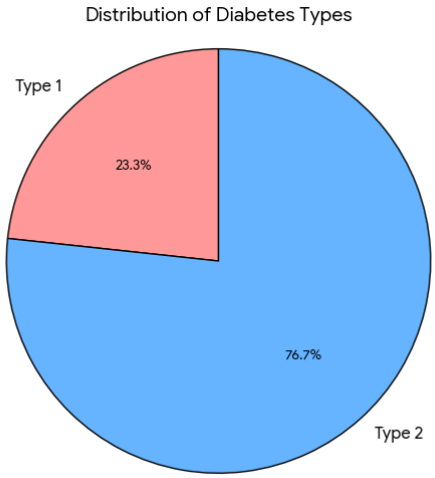

Figure 3. *Distribution of Diabetes Types*

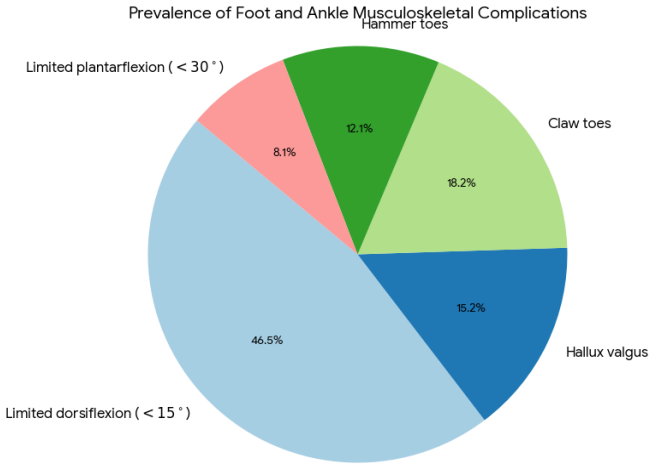

Figure 4. *Prevalence of Foot and Ankle Musculoskeletal Conditions*

Discussion

The frequency of foot and ankle musculoskeletal problems among diabetic patients was investigated in this research along with their link with neuropathy, pain level, and length of diabetes. Our results show that Pakistani diabetic patients often experience musculoskeletal problems influencing the foot and ankle [8]. The most common mobility restriction, restricted ankle dorsiflexion (<15°), was seen in 46% of participants; after that, claw toes (18%) and hallux valgus (15%) followed (Table 2). These results support earlier studies demonstrating how chronic hyperglycemia promotes collagen glycation, connective tissue rigidity, and joint contractures [9].

Constricted ankle dorsiflexion has major biomechanical effects. Reduced dorsiflexion raises forefoot loading during gait, which can make patients susceptible to plantar ulceration [7]. With a mean dorsiflexion of 14.2° (SD 4.3), our research confirms limited mobility among several patients (Table 3). These data point up the necessity of evaluating ankle ROM in regular diabetic care to find people most likely to experience foot problems.

As shown in Table 4, foot abnormalities including hallux valgus (χ^2=6.41, p=0.011) and claw toes (χ^2=5.38, p=0.020) were very linked with peripheral neuropathy. This fits with the established pathophysiology in which motor neuropathy results in intrinsic muscle weakness, hence producing structural abnormalities and changed plantar pressure distribution [5]. These abnormalities might raise local stress, hence increasing ulcer risk and causing pain. Additionally, a strong positive association among pain intensity as well as neuropathy rating ($r = 0.51$, $p < 0.001$) was found during the correlation analysis, indicating that individuals with advanced neuropathy are more uncomfortable (Table 5) [10].

(Table 5) demonstrated that the duration of diabetes was favorably correlated with the degree of foot abnormality ($r = 0.35$, $p = 0.003$) and negatively correlated along with ankle dorsiflexion ($r = -0.42$, $p = 0.001$). These results point to a gradual degradation of joint function and more structural abnormalities with more

hyperglycemia exposure. Zimny reported comparable findings of greater joint stiffness in diabetics with long-standing illness. This especially in patient with a longer disease duration stresses the necessity of early detection and treatment [10].

All of these results highlight the importance of early musculoskeletal testing for people with diabetes. Stretching activities, ankle mobilization, strengthening regimens, orthotic appliances, and client training are among strategies that may assist preserve ankle mobility, reduce forefoot stress, and halt the development of foot deformities [5]. Clinicians should incorporate routine examinations of foot anomalies, ankle range of motion, as well as neuropathy into diabetes treatment programs, especially in underprivileged settings wherein these issues are frequently misdiagnosed. [3].

Conclusion

Diabetic patients have very common foot and ankle musculoskeletal issues that are strongly correlated with neuropathy, pain severity, and diabetes duration [8]. Early detection by means of clinical examination and prompt preventative measures can help to lower the risk of severe results including amputations and plantar ulcers and so lessen functional disability. Improving patient outcomes and pointing towards specific rehabilitation techniques in clinical practice call for integrating musculoskeletal screening into regular diabetic care [2].

Limitations

- The cross sectional design of the study restricted the capacity to prove causal links between neuropathy, diabetes duration, and musculoskeletal issues [10].
- The findings' generalizability to the bigger diabetic Pakistan population may be constrained by the fact that the sample came from a single clinical center [1].
- Missing were objective measures of plantar pressure and gait mechanics that could have offered more thorough biomechanical analysis [3].
- Self reported pain intensity can be affected by recall bias [5].

Future Recommendations

- Longitudinal researches are mandatory to evaluate the temporal route of foot as well as ankle muscular problems into diabetic patients [6].
- Bigger multicenter trials could help to increase generalizability and enable regional and patient population comparisons [1].
- Inclusion of sophisticated biomechanical evaluations such gait analysis and plantar pressure mapping would help to clarify the functional consequences of musculoskeletal disorders [2].
- Studies evaluating how well physiotherapy, orthotics, and patient education help to avoid problems are advised [3].

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Data Availability

The data used in this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflict of interest and received no specific funding for this work.

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