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# INFLUENCE OF FOOT PAIN ON WALKING ABILITY OF DIABETIC PATIENTS

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***Objective:*** **To assess foot pain and its correlation with walking ability in diabetic patients.**

***Subjects:*** **Two groups of type 2 diabetic patients (30 with symptomatic neuropathy and 30 without symptomatic neuropathy) and 30 healthy volunteers were studied.**

***Methods:*** **Pain was assessed by the pain sub-scale of the Foot Function Index. Internal consistency for the pain sub-scale was tested. Walking ability was assessed by the 6-minute walking test.**

***Results:*** **The pain was worse in diabetic patients, the pain sub-scale scores differed between the groups ($p < 0.05$). High internal consistency was found for the pain sub-scale of the Foot Function Index. Results of the 6-minute walking test differed among the 3 groups: healthy volunteers performed best, and diabetic patients with symptomatic neuropathy worst ($p < 0.001$). Foot pain correlated moderately with the result of walking test ($r = -0.449$, $p < 0.001$).**

***Conclusion:*** **The pain sub-scale of the Foot Function Index is suitable for the assessment of pain in diabetic patients. Patients with severe foot pain have more difficulties when walking long distances than patients with less severe or without any pain.**

*Key words:* diabetic neuropathy, Foot Function Index, 6-minute walking test, foot pain.

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## INTRODUCTION

Foot pain is one of the major impairments caused by diabetic neuropathy (1, 2). Diabetic neuropathy is the most frequent and also the most unpleasant complication of diabetes (3–5). It presents a group of clinical syndromes, among which the most frequent is distal, mainly sensory polyneuropathy. Sensory neuropathy may cause impairment and activity limitation in these patients, and affect the quality of life (3, 6). The prevalence of peripheral neuropathy among diabetic patients is generally high; according to data from the literature it occurs in an extensive span ranging from 0% to 93%, depending on population included and different diagnostic criteria (4, 7–13).

The first characteristics are usually positive (burning sensations, pain, pricking, tingling) and negative (anaesthesia and analgesia, hypoesthesia and hypoalgesia) sensory symptoms in the limbs (3, 6, 9, 14–18). In distal sensory neuropathy deficits occur in a symmetrical stocking-and-glove pattern (3, 19). Neuropathic pain may be spontaneous, or triggered by normally painless stimuli (temperature change, mechanical stimulation of the skin) – alodynia, or by emotional factors. The main problem may be hyperaesthesia or hyperpathia (3, 16, 20–23). The problems are usually worse at night or when resting (16, 20, 24, 25).

Walking ability is important for preserving independence and to maintain a high degree of quality of life (26–29). The reduced walking ability is affected not only by ageing (30, 31), but also by numerous other factors (degenerative states, diseases and injuries affecting the bones, joints and muscles as well as the central and peripheral nervous systems, and diseases of the circulatory and respiratory systems, etc.). In diabetic patients, an important factor is the disturbed functioning of the small nerve fibres and the associated foot pain (6). Foot pain is not only a difficulty in itself, but also has an influence on the degree of fatigue, on patient activity and on the overall feeling of well being (6).

The objective of the study was to assess the foot pain and its impact on walking ability in older healthy volunteers, in type 2 diabetic patients without symptomatic neuropathy, and in type 2 diabetic patients with symptomatic neuropathy.

## MATERIAL AND METHODS

### *Subjects*

We included type 2 diabetic patients with symptomatic neuropathy (30 subjects), type 2 diabetic patients without symptomatic neuropathy (30 subjects) and healthy volunteers (control group, 30 subjects). Type 2 diabetic patients were referred to us from the diabetic outpatient clinic at University Medical Centre Ljubljana. Healthy volunteers were recruited among hospital staff, their relatives and acquaintances.

Diagnosis of diabetic neuropathy was established according to history data on the symptoms characteristic of diabetic neuropathy (burning sensations, pain, tingling, anaesthesia and analgesia, hypoesthesia and hypoalgesia in the feet) and confirmed by quantitative and qualitative assessment of thermal specific and thermal pain thresholds (32–35).

Patients who had at least 1 of the symptoms were included in the group with symptomatic neuropathy.

The groups were gender and age matched, with 20 women and 10 men in each group. The average age of the subjects did not differ between the individual groups ($p = 0.432$) ($61.37 \pm 10.29$ years in healthy volunteers, $62.13 \pm 11.46$ years in type 2 diabetic patients without symptomatic neuropathy and $64.87 \pm 11.07$ years in type 2 diabetic

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Table I. *Descriptive statistic and non-parametric Kruskal Wallis test for assessing the pain sub-scale of the Foot Function Index*

| | *n* | Mean (SD) | Min–Max | Mean order | Hi-square | DF | *p* for KW |
|---|---|---|---|---|---|---|---|
| Control group | 30 | 2.59 (4.14) | 0–15.87 | 28.38 | | | |
| DM without N | 30 | 6.19 (7.98) | 0–22.22 | 34.53 | 56.437 | 2 | <0.001 |
| DM with N | 30 | 53.29 (24.92) | 1.59–100 | 73.58 | | | |
| Total | 90 | 20.69 (27.72) | 0–100 | | | | |

SD = standard deviation; DF = degree of freedom; KW = Kruskal Wallis test; DM without N = type 2 diabetic patients without symptomatic neuropathy; DM with N = type 2 diabetic patients and symptomatic neuropathy.

patients with symptomatic neuropathy) or gender ($p = 0.813$) ($62.98 \pm 11.24$ years in women and $62.40 \pm 10.43$ years in men).

Patients who had experienced pain due to any other causes, patients with cognitive disturbances, and patients in whom their general state of health or other diseases might have influenced the result of the 6-minute walking test were excluded from the study.

All subjects signed an informed consent. The study conforms with the Helsinki Declaration on biomedical study and the provisions of the Oviedo convention. The work was been approved by the State Commission for Medical Ethics.

The investigations were carried out by the first author.

*Assessment of pain by means of the pain sub-scale of the Foot Function Index*

Foot pain was assessed by using the pain sub-scale of the Foot Function Index (FFI) (36). FFI comprises 23 items, divided into 3 sub-scales for the assessment of foot pain (items 1–9), disability (items 10–18) and activity limitation due to foot problems (items 19–23). The subject responded to the items from all 3 of the sub-scales by using the visual analogue scale (VAS). The values obtained on VAS were coded with values from 0 to 9. To obtain a sub-scale score, the item scores for a subscale were totalled and then divided by the maximum total possible for all of the sub-scale items, which the patient indicated, were applicable. Any item marked as non-applicable was excluded from the total possible. Scores were obtained for the total FFI and the 3 sub-scales. In this article only the scores of the pain sub-scale are presented. The pain sub-scale consists of 9 items measuring the level of foot pain in a variety of situations. In our study 2 items related to the wearing of orthotics were excluded, as none of the patients had ever used them.

*Assessment of walking ability with the 6-minute walking test*

The influence of impairment (pain) on the patients' activity limitation (walking ability) was objectively assessed by the 6-minute walking test. The subjects walked as fast as possible for 6 minutes along a marked 70-metre long circular path in the gymnasium and the corridor, but were not allowed to run. If necessary, they could stop, sit down and rest and then continue walking. The walking distance was measured at 5-metre intervals.

*Statistical analysis*

Results were analysed by SPSS 10.1 (Statistical Package for Social Sciences 10.1). The pain sub-scale scores differences between the test groups were analysed with non-parametric Kruskal Wallis test. The internal consistency of the pain sub-scale of the FFI was checked by calculating the Cronbach's alpha. The results of the 6-minute walking test were assessed with the analysis of variance (ANOVA). Finally, the Pearson's parametric correlation was used to establish correlation between the pain sub-scale scores and the results of the walking test.

## RESULTS

The mean duration of diabetes was $8.59 \pm 8.13$ years in type 2 diabetic patients without symptomatic neuropathy and $14.85 \pm 7.85$ years in type 2 diabetic patients with symptomatic neuropathy. The difference between the 2 groups was statistically significant ($p = 0.004$).

*Foot Function Index*

The calculated Cronbach's alpha for the pain sub-scale was high ($\alpha = 0.9752$).

The healthy subjects attained the lowest scores, type 2 diabetic patients without symptomatic neuropathy slightly higher scores, and type 2 diabetic patients with symptomatic neuropathy the highest scores on the pain sub-scale. The differences between the groups were statistically significant ($p < 0.05$) (Table I, Fig. 1).

*The 6-minute walking test*

During the 6-minute walking test the healthy subjects walked the longest distances ($629.17 \pm 110.33$ metres). Type 2 diabetic patients without symptomatic neuropathy walked shorter distances ($530.17 \pm 107.86$ metres), but still longer than type 2 diabetic patients with symptomatic neuropathy ($466.33 \pm 114.33$

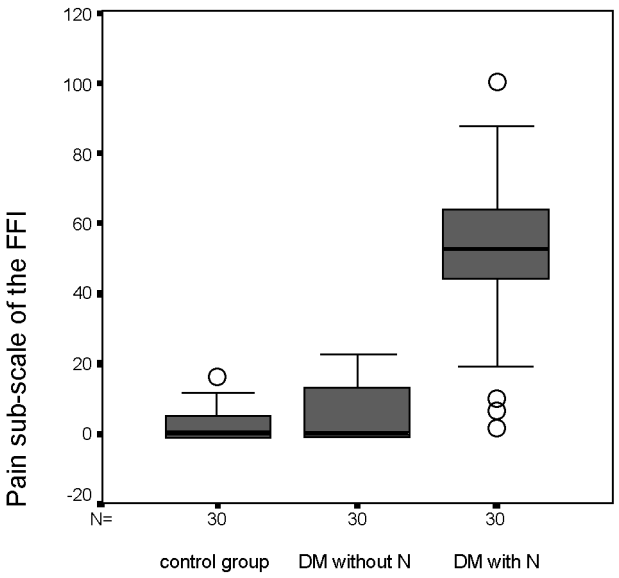


*Fig. 1.* The "box-plot" diagram for assessment with the pain sub-scale of the Foot Function Index (FFI). The box represents the interquartile range, which contains the 50% of values. The whiskers are lines that extend from the box to the highest and lowest values, excluding outliers. Outliers are cases with values between 1.5 and 3 box lengths from the upper or lower edge of the box. A line across the box indicates the median. N = number of test subjects; DM without N = type 2 diabetic patients without symptomatic neuropathy; DM with N = type 2 diabetic patients with symptomatic neuropathy; ○ = outliers. Differences are significant ($p < 0.05$).

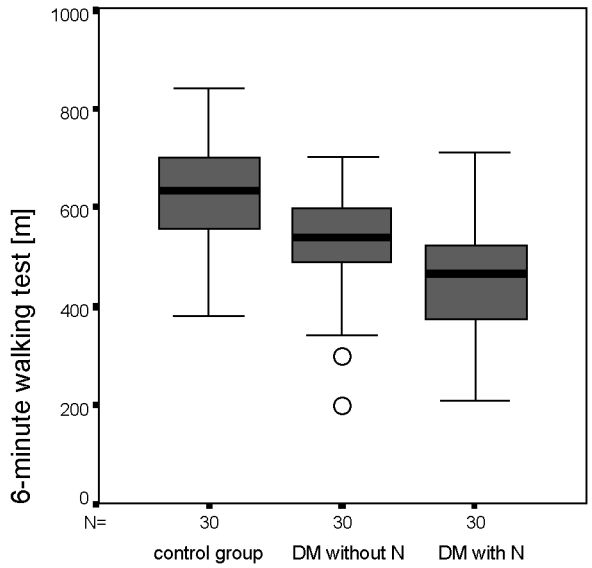


*Fig. 2.* The "box-plot" diagram for the result of the 6-minute walking test. The box represents the interquartile range, which contains the 50% of values. The whiskers are lines that extend from the box to the highest and lowest values, excluding outliers. Outliers are cases with values between 1.5 and 3 box lengths from the upper or lower edge of the box. A line across the box indicates the median. N = number of test subjects; DM without N = type 2 diabetic patients without symptomatic neuropathy; DM with N = type 2 diabetic patients with symptomatic neuropathy; ○ = outliers. Differences are significant ($p < 0.05$).

metres). The differences between the individual groups were statistically significant ($p < 0.001$) (Fig. 2).

### *Correlation between the pain sub-scale and the result of the walking test*

The correlation between the results of the pain sub-scale and the walking test was moderate ($r = -0.449$), and statistically significant ($p < 0.001$).

## DISCUSSION

Foot pain was assessed by means of the pain sub-scale of the FFI. The questionnaire has been developed for use in patients with rheumatoid arthritis (36), while in type 2 diabetic patients – according to data from the literature available to us – it has so far only been used in the study by Rijken et al. (6), and therefore we have checked its internal consistency. The pain sub-scale demonstrated a high level of internal consistency, which means that all items contributed towards assessment of the same phenomenon. The calculated Cronbach's alpha was even somewhat higher than in the study of the authors' scale (36). In our study, the consistency of the pain sub-scale was greater than in the only comparable study of diabetic patients (6). The pain sub-scale of the FFI proved to be an effective instrument for assessing foot pain in diabetic patients.

We confined our work on assessment of pain in diabetic patients. The study has shown that diabetic neuropathy is an important cause of foot pain, which is in agreement with the findings of Vinik (5), Rijken et al. (6) and Weintraub et al. (37). Further studies are needed for the evaluation of impairment of the sensorymotor system in diabetic patients, which should include different levels of sensory and motor system and their interactions.

Healthy subjects and type 2 diabetic patients without symptomatic neuropathy attained low scores on the pain sub-scale of the FFI. VAS ratings given by the healthy subjects in our study were so low that they can be considered as no pain according to Jensen et al. (38). Ratings given by type 2 diabetic patients without symptomatic neuropathy suggested very mild foot pain. The pain was suggested by the questionnaire. These patients were included to the asymptomatic group, because they did not spontaneously report on foot pain at the interview.

In our study, type 2 diabetic patients with symptomatic neuropathy, on the pain sub-scale, attained notably higher scores than did the patients with rheumatoid arthritis in the study by the authors of the scale (36). The variability of our results is comparable to the variability of the results in the studies mentioned above. In our study, the score of the pain sub-scale in the group of type 2 diabetic patients with symptomatic neuropathy was almost 2 times higher than in the patients in the Dutch study (6), with equal variability. The average duration of diabetes was equal in both studies. The cause of this difference is not clear. Since there are no other comparable study studies, and since there are deficiencies in the data on the subjects included in the Dutch study, we were unable to draw any conclusion on the basis of the differences described.

In the literature available to us, we found only 1 study (6) on the influence of pain on walking ability in patients with diabetic neuropathy. In that study, patients with diabetic neuropathy attained notably worse results in the 6-minute walking test than did our subjects with diabetic neuropathy, however the instructions given to the subjects in both studies were different. In our study, we asked the patients to walk as fast as possible (which is in accordance with the instructions of the authors of the test (30)), while the patients in the study by Rijken et al. (6) walked at their natural pace. Katoulis et al. (39) found that patients with diabetic neuropathy walk more slowly than healthy subjects, which is in agreement with our findings. The same researchers – in contrast to our findings – did not record statistically significant differences in walking speed between the group of healthy subjects and the group of diabetic patients without symptomatic neuropathy (39). The results of extensive study in the USA have revealed that, in a walking test (3.5 metres), older diabetic patients walk significantly more slowly than healthy subjects (27). In comparison to the original study, the correlation between foot pain and walking ability in our study was moderate, while in patients with rheumatoid arthritis it was low. In the original study, a different walking test (15 metres) was used, therefore the comparison is questionable. The correlation between the result of the pain sub-scale and the result of the 6-minute walking test in patients with diabetic neuropathy in the Dutch study was somewhat higher than in our test subjects.

On the basis of our study we may say that the foot pain was moderately, but significantly linked to the achievement in the walking test ($p < 0.001$). Patients with more severe foot pain had more difficulties when walking for longer distances than did patients with less severe or without pain.

Foot pain due to neuropathy is one of the factors affecting walking ability. By reducing foot pain we can also make walking easier, and hence significantly improve the quality of life of diabetic patients.

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