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Comparison of Pressure on Different Areas of the Foot in Military and Non-Military Patients with Diabetes Referred to a Hospital

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A B S T R A C T

Insulin-independent diabetes mellitus (type 2 diabetes) is a metabolic disease characterized by the body's inability to produce enough insulin for effective and efficient use of sugars, fats, and proteins. Diabetes has many complications that foot ulcers are one of the most common ones. People working in the armed forces of various countries generally need to have greater mobility and if they suffer from debilitating complications such as diabetic foot ulcers or possibly amputation, they will lose a significant portion of their effectiveness. The aim of this study was to determine the amount of pressure on the feet of military personnel and compare with non-military people. The study population included 86 men with type 2 diabetes and a no history of lower limb amputation, impairment in the lower limbs, injury or diabetic foot ulcers. Various parameters were measured and recorded such as variables associated with patient's general condition, foot examination, gait analysis, plantar pressure and laboratory measurements. The data collected were analyzed using SPSS software. There is a significant relationship between the pressure on different areas of the foot and being military (P-Value<0.05). The pressure on different areas of the foot in military diabetic patients is more than non-military people. This could be due to the use of special shoes and vigorous physical activity in military personnel.

Introduction

Insulin-independent diabetes mellitus (type 2 diabetes) is a metabolic disease characterized by the body's inability to produce enough insulin for effective and efficient use of sugars, fats, and proteins.

Insulin-independent diabetes mellitus is more common in obese adults than in others. All cells require insulin to transport glucose from the blood into the cells. A large number of people are involved in the disease in third world countries like Iran per year (1,2). It was anticipated by 2010 that approximately 285 million people worldwide were infected with type 2 diabetes and constituted about 90% of the total population of diabetics. This amount is equal to 6% of the total youth population in the world. Diabetes is increasing in both developed and developing countries. According to its growth rate, it is anticipated that 366 million people will be affected by the disease by 203)3(.It is said that this increase is mainly due to the aging of the population, reduction in sporting activities and increased rates of obesity. 90% of diabetic people suffer from type 2 diabetes and the other 10% from diabetes mellitus type 1 and gestational diabetes, respectively. It is said that obesity is a major cause of type 2 diabetes in people who are genetically prone to the disease. Other reasons can be immobility, high blood pressure, low HDL or high triglycerides)4(.Direct costs of diabetes has been registered equivalent to 45.2 billion in America's health system in 1992)5(.According to increasing number of people suffered from diabetics, it is anticipated that the total costs associated with the treatment of the disease will reach from 376 billion dollars to 490 billion dollars by 2030 diabetes in all countries have reached more than and given to the growing rate of the value, it is anticipated to reach)6(.According to the anticipation of International Diabetes Federation (IDF), the number of diabetic people has been 9.3% in 2011 and the rate will reach 13.1% by 2030)7(. Expenses consumed for type 2 diabetes had amounted to 3.78 billion dollars in 2009 in Iran)8(. The most complications were related to peripheral neuropathy and diabetic foot ulcers, which cost less than other diseases. However, complications such as amputation, in which artificial limbs are required, require substantial expenditures. Diabetes is the most common cause of nontraumatic lower-limb amputation)9(.

Attention to health care actions can prevent amputation to a great extent)10(.Factors such as neuropathy, vasculopathy and diabetic foot ulcers are considered as risk factors for lower limb amputation)11(. Factors such as weight, BMI, sensory impairment in the lower limbs with frequent pressure on the member, deformities, limited range of foot motion simultaneous with peripheral nerve disorders, high plantar pressure and some other items such as glycated hemoglobin level, previous history of diabetic foot ulcers or amputation for this reason, fasting blood glucose, oxygen pressure difference across the skin, serum creatinine level, touch sensation precisely assessed using monofilament, edema of the lower limbs and tendon reflexes are mentioned as predictors of diabetic foot ulcer)18-12(. The importance of evaluation and classification of patients based on their biomechanical properties has been recommended in various studies)19 ,20(. The importance of the type of shoes has been studied as a factor affecting diabetic foot ulcer)24-21(The results of a . number of studies showed that people's shoes and the duration of shoe-wearing affect the plantar pressure distribution and indirectly the risk of diabetic foot ulcers and diabetic foot ulcers can be reduced by applying some changes in shoes)29-25(.People working in the armed forces of various countries generally need to have greater mobility and if they suffer from debilitating complications such as diabetic foot ulcers or possibly amputation, they will lose a significant portion of their effectiveness and consequently, their early retirement and

health care costs associated with their certain medical conditions will impose some additional costs to the military health budget. Given the role of the shoe on the foot biomechanics changes, plantar pressure distribution and finally, the likelihood of developing diabetic foot ulcers and with respect to the use of military boots in training courses, parades and a variety of military exercises and operations, the present study was designed to investigate differences in the prevalence of risk factors for diabetic foot ulcers between civilians and military personnel. If we find a significant difference between the prevalence of risk factors for diabetic foot ulcers in military personnel and civilians, the present design will be extended in order to determine guidelines, recommendations and preventive measures to reduce diabetic foot ulcers in people employed in the armed forces.

Materials and Methods

Introduction of studied variables

This study was conducted as an observational study with a retrospective case-control design. Statistical population included 86 (43 military and 43 non-military) men with type 2 diabetes and no history of lower limb amputation, lower limb deformity, injury or diabetic foot ulcers and known neuromuscular disease, able to walk without help and refer to diabetes and endocrinology clinics at Imam Khomeini hospitals of Tehran. The variables examined in this study are demographic and biographical information (age, weight, height and blood pressure, duration of diabetes, history of smoking), job - related variables (being military or non-military, history of wearing boot), laboratory variables (serum fasting blood sugar levels, serum creatinine levels, blood urea nitrogen serum levels, LDL, HDL), findings of foot examination, gait analysis and plantar pressure, such as calluses, analysis of muscle mass, dry skin, hallux valgus, claw and hammer toe, exact touch sensation scoring using monofilament, position and vibration sensation, deep tendon reflexes, velocity of deep peroneal and tibial nerves, *a*mplitude of deep and superficial peroneal, Tibial and sural nerves, latency of deep and superficial peroneal, Tibial and sural nerves, F wave latency of deep peroneal and tibial nerves, H-reflex latency of Tibial nerves, step length, cadence, walking speed, stride length, total double support, stance phase, swing phase, load response, single support, pre-swing phase, step width/ time, the maximum pressure in different areas of the foot, such as toe, toe metatarsal, small fingers, the front part of the foot, middle part of the foot, internal heel, external heel.

Research Methods: Patients were examined physically after taking biography and then referred to the biomechanics laboratory for examination of plantar pressure distribution and gait analysis. Raw data obtained was entered into SPSS statistical software.

Data analysis: Data was analyzed using SPSS statistical software. Chi-square was also used for qualitative variables and t test for quantitative variables and Mann-Whitney U test (based on data type) for comparing data distribution. The impact of clinical signs of pressure on different areas of the foot was evaluated by correlation tests. The impact of some of the most important clinical characteristics on the amount of pressure on different areas of the foot was examined using regression. In all cases, p value <0.05 was considered statistically significant.

Result and Discussion

The present study was performed on 86 (43 military and 43 non-military) patients referred. The age of participants was

reported between 25 and 75 (with mean age of 57.41 years) and their height ranged from159 to 185 cm, with the mean height of 171.23 cm. the mean of participants'BMI was 28.43 in the study that is higher than normal level.The weight of the subjects ranged from 63 to 107 kg, with the mean weight of 81.461 kg with SD = 1.087. Mann - Whitney U nonparametric statistical test was used to study the relationship between job status (military/non-military) and plantar pressure in abnormal data. As seen in table 1, occupation status has had an effect on Right First Metatarsal Peak Plantar Pressure and Left First Metatarsal Peak Plantar Pressure (P-Value<0.05).

Comparison of different variables between military and non-military personnel indicated that the level of risk factors in diabetic military personnel is higher than in non-military ones. For example, BMI of military personnel is more than that of non-military ones. Also, HbA1C in military and non-military personnel is 8.0667 and 7.614, respectively (Table 2).

Plantar pressure was measured and compared in both groups. Table 3 compares the pressure to different parts of the foot in both groups. In most variables, the rate of plantar pressure in military personnel is more than that in non-military ones.

Table.1 Effect of job status on the amount of pressure on different areas of the foot

	Right First Metatarsal Peak Plantar Pressure	Left First Metatarsal Peak Plantar Pressure	Left Fifth Metatarsal Peak Plantar Pressure	Left Midfoot Peak Plantar Pressure
Mann-Whitney U	156.5	213.5	247.0	297.5
Z	-3.31	-2.26	-1.15	-0.72
P-Value	< 0.01*	0.02*	0.25	0.47

Table.2 Comparison of factors influencing on diabetics in both military personnel and civilians

Variable	Military personnel	Civilians	P values
BMI	29.08	27.89	0.23
HbA1C	8.07	7.61	0.37
LDL	90.25	93.21	0.73
HDL	38.12	44.04	0.05
TG	17.57	19.27	0.39
Total-Cholesterol	163.58	169.36	0.64
Uric-Acid	5.72	6.02	0.39

In this study, the relationship between clinical signs with pressure on different areas of the foot was examined. The results suggest that some clinical symptoms in both groups, like weight, age, Stride Length, Step Length, Latency Tibial/ DPN, Amplitude Tibial/ DPN, Velocity Tibial/ DPN, affect some areas of the foot like Hallux Peak plantar Pressure, Second Metatarsal Peak Plantar Pressure, Third Metatarsal Peak Plantar Pressure, Fourth Metatarsal Peak Plantar Pressure, Midfoot Peak Plantar Pressure and Lateral Heel Peak Plantar Pressure (P-value<0.05). In this study, the effect of some clinical characteristics on the amount of pressure on different areas of the foot was studied using regression statistical test (Table 2).

Table.3 Comparison of pressure to different parts of the foot in both military and non-military groups

Variable	Military Personnel	Civilians	P values
Left Second Metatarsal Peak Plantar Pressure	21.21	26.25	0.002
Right Third Metatarsal Peak Plantar Pressure	22.57	27.75	0.007
Left Third Metatarsal Peak Plantar Pressure	23.71	28.67	0.002
Right Lesser toes Peak Plantar Pressure	9.78	6.67	0.007
Right Medial Heel Peak Plantar Pressure	24.14	27.75	0.024
Left Medial Heel Peak Plantar Pressure	23.86	29.83	< 0.001
Right First Metatarsal Peak Plantar Pressure	18.57	27.42	0.002
Left First Metatarsal Peak Plantar Pressure	22.43	29.50	0.019

Identifying risk factors for diabetes can prevented its various complications. One of the most common complications of diabetes is diabetic foot ulcers, causing great financial costs for treatment, rather than amputation. Several studies have investigated risk factors for diabetic foot ulcers. A study conducted in Australia)30(assessed the impact of neuropathy status on foot ulcer. The results of this research showed that neuropathic ulcer significantly increases plantar pressure and reduces ankle joint flexibility. Also in a similar study of Lowry et al.)31(some factors such as neuropathy, foot deformities, high plantar pressure and a history of lower limb amputation have been introduced as risk factors for diabetic foot ulcers. In present study, pressure on different parts of the foot was studied in both military and non military groups. The result showed that the amount of pressure on different parts of the foot in military personnel is higher than in non-military ones. This may be due to long-term use of boots during the years. Also, military activities such as parades and heavy physical exercises can be considered as plantar pressure risk factors correlated with. The type of shoe is mentioned as a factor to increase the pressure on the foot in other studies. Other underlying factors such as age and weight are effective on the onset of diabetes in the military personnel. Type 2 diabetic military personnel are generally older with a higher body-mass index and HbA1C, as well as, lower HDL. Based on results from a study in USA, age, sex, BMI, education, race/ethnicity, military service characteristics, and mental health conditions, only baseline posttraumatic stress disorder (PTSD) was significantly associated with risk of diabetes (32**).** Also in other study, increased BMI and race are two major factors associated with type 2 diabetes (33). The results of our study showed that neuropathy status effects the pressure on different areas of the foot in military personnel, such as Right First Metatarsal Peak Plantar Pressure and Left First Metatarsal Peak Plantar Pressure (p-value<0.05). With respect to the general characteristics of military patients, it was shown that the higher the age and the weight, the higher the amount of pressure on different areas of the foot. Therefore, different risk factors can increase the plantar pressure in different parts of the foot.

Conclusion

The amount of plantar pressure in military patients is more than in others. It seems that it is as a result of prolonged use of boots and heavy activities. Due to the sensitive nature

of their job, some measures should be taken to manage the duration of boot usage. Also, regular checkup of military personnel is necessary for awareness of factors causing and aggravating diabetes.

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