CORRELATION OF BODY MASS INDEX (BMI) AS A MODIFIABLE RISK FACTOR IN DIABETIC FOOT ULCER FORMATION. A VALIDATION STUDY

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ABSTRACT

Objectives: To analyze the effect of weight gain and obesity on the characteristics of diabetic foot ulcer along with associated complications and outcomes.
Study Design: Analytical (Observational)
Setting: Department of medicine/surgery, Khyber Teaching Hospital, Peshawar.
Duration: From 1st July 2024 to 31st December 2024.
Methodology: After attaining approval from the hospital ethical and research committee, the following study began with a sample size of 125 patients, all added through non-probability consecutive sampling technique. The following parameters were considered: age, gender, education, MR number, contact number, locality, duration of T2DM, outcomes, complications, characteristics of the ulcer and the BMI. The data was added to Microsoft Excell and transferred to SPSS version 23.0 for data analysis. Pearson chi-square test was utilized to measure correlation and regression. Results are shown in the form of description, tables and charts.

Results: Out of 125 patients recruited for the study, 32 (25.4%) were females and 94 (74.6%) patients were males with a mean age of 57.8 ± 0.617. Patients who were not obese had healthier margins (p value = 0.04), better outcomes (p value= 0.05) and had the ulcer for a lesser duration of time (p-value 0.016) as compared to their counterparts. Exactly 23 (18.4%) patients, who were obese, had to undergo either toe or trans-metatarsal/midtarsal amputation.

Conclusion: Obesity has a negative impact on wound healing through pressure effects and compromised circulation hence leading to the formation of diabetic foot ulcers with poor outcomes.

INTRODUCTION

Diabetic foot is a distressing medical as well as a surgical condition, proving costly not only for the patient but also for the hospital's financial resources. Among people with DM, diabetic foot ulcers (DFUs) constitute the largest proportion of admissions, amputations and mortality [1-2]. There is a complex interplay between multiple pathological processes at microscopic level that lead to the formation of a diabetic foot ulcer from neuropathies and myopathies to osteoarthropathies and peripheral arterial disease. The management of diabetic foot ulcers is multiplex, involving care and attention from several departments and specialties. The inevitable outcome of increasing prevalence of Type 2 diabetes mellites is that, despite improvements in the management of diabetes, there is still likely to be a disturbing increase in the number of people suffering from the long-term complications of the disease[3].

Obesity is defined as abnormal and excessive fat accumulation that can interfere with health and can also generally be defined based on obtained BMI, where weight in kilograms is divided by height in meters squared. The main cause of obesity is an imbalance of calories in and decreased physical activity[4]. BMI is calculated as the body weight of the individual patient divided to the square of their height; and we considered BMI ranges < 18.5 kg/m^2 = underweight, BMI ranges 18.5–24.5 kg/m^2 = normal range, BMI ranges from 24.5 to 30 kg/m^2 = overweight and BMI > 30 kg/m^2 = obese. Based on the WHO classification, a person is said to be obese if the BMI value is 30 kg/m2 and is at high risk of experiencing several other diseases such as diabetes, cardiovascular disease, hypertension, dyslipidemia, musculoskeletal disorders, worsening quality of life and even death[5]. Similar studies suggest that obesity is a major contributing factor to insulin resistance and type 2 diabetes mellitus[6]. Obesity itself, as well as hypertriglyceridemia, can directly increase the risk of developing peripheral neuropathy. Subcutaneous tissue thickness in obese individuals is thought to reduce the amplitude of sensory responses when given percutaneous simulation[7].

DFUs coexists with an increasing prevalence of obesity which has been reported to alter antimicrobial susceptibility and potentially affect the outcome of infected foot ulcers. Data from studies suggested that there may be a strong link between body mass index (BMI) and the formation of chronic DFUs[8-9]. Obesity leads to higher adipose levels in the body and triglycerides in the blood which leads to several pathological mechanisms that alter the bodies healing capabilities and the immune system. Due to pressure effects and hyperlipidemias, the body's microcirculation is compromised,[10]

hence leading to necrosis and ischemia. This process has a negative impact on healing, thereby encouraging the growth of both bacteria and fungi[11]. Hence these findings are strong clues indicating a connection between weight gain and the formation of chronic DFUs from superimposed infections and infestations. Therefore, this study aims to determine whether obesity and weight gain affect the progression and healing of diabetic foot ulcers in people with type 2 diabetes in a tertiary care hospital in Khyber Pakhtunkhwa.

MATERIALS AND METHODS:

After attaining approval from the hospital ethical and research evaluation committee, the following clinical trial began with a sample size of 125 patients (both genders), age 30 and above, selected through a nonprobability consecutive sampling technique, who were included in the study. The study duration was 6 months (from 1st August 2023 to 31st December 2024). Using a single center at this point helped to ensure uniformity in patients' foot care and potentially minimize bias. Clinicians identified eligible participants, based on inclusion and exclusion criteria. Patients with DFU with below normal body mass index (BMI below 18), known history of any other comorbidity such as liver cirrhosis, renal failure or congestive cardiac disease along with any obvious sign of advanced gangrene were excluded. Participants were newly reported and known patients with T2DM with DFUs of any Wagner grade (Bar chart1). DFU will be defined as a full-thickness wound, through the dermis, below the ankle in an individual with T2DM. Prior to commencement of the study, appropriate manuals and standard operating procedures will be prepared and used throughout the study period. The following demographic parameters were recorded: name, age gender, education, address, body mass index (BMI), duration of diabetes, characteristics of diabetic foot ulcer, treatment and outcomes. Management of diabetic foot patients typically includes tight blood glucose control, wound care and standard double regimen antibiotics. The data obtained were analyzed, and the results were compared with those of similar studies done elsewhere. All the data collected through fulfilling of proformas was added to Microsoft excel sheet and transferred to SPSS version 23.0. for data analysis and verification. The results are illustrated in the form of description. Tables, and charts

RESULTS:

Out of 125 patients recruited for the study, 32 (25.4%) were females and 94 (74.6%) patients were males with a mean age of 57.8 ± 0.617. All other descriptive statistics of quantitative variables are discussed in detail in table 1. Patients presented with levels of body mass index (BMI) that varied a lot, however, most of the patients had a BMI in the range of 28-31(n=60, 48%) with 80 patients who were overweight according to WHO scale with details shown in table 2 and pie chart 1. Characteristics of the ulcers with their respective statistics are illustrated in table 3. In terms of Wagner grade, 54 (42.9%) patients were class 2, and 53 (42.1%) patients were class 3 (details given in bar chart 1). Furthermore, as far as outcomes are concerned, the ulcers healed completely in 102 patients, and 23 patients had to go either toe or trans-metatarsal/midtarsal amputation. The Pearson chi square test was applied to test the correlation between risk factor (obesity) and outcomes(healing/amputation). Patients who were not obese had healthier margins (p value = 0.04), better outcomes (p value= 0.05) and had the ulcer for a lesser duration of time (p-value 0.016) as compared to their counterparts. The details of the correlation are shared in table 3.

Table 1: Descriptive statistics of quantitative variables.

Variable	Range	Minimum	Maximum	Standard Deviation	Mean
Age	32	42	74	6.897	57.75
BMI	15	25	40	3.385	29.37
Duration of DM	6	2	8	1.479	4.81
HBA1C	3	6	9	.488	7.01
Duration of ulcer (weeks)	11	1	12	2.278	4.71

Table 2: Distribution of patients according to WHO classification.

BMI class	Frequency	Percentage
Overweight	80	63.5
Class 1	33	26.2
Class 2	10	7.9
Class 3	3	2.4

Pie chart 1: Distribution of patients according to WHO classification.

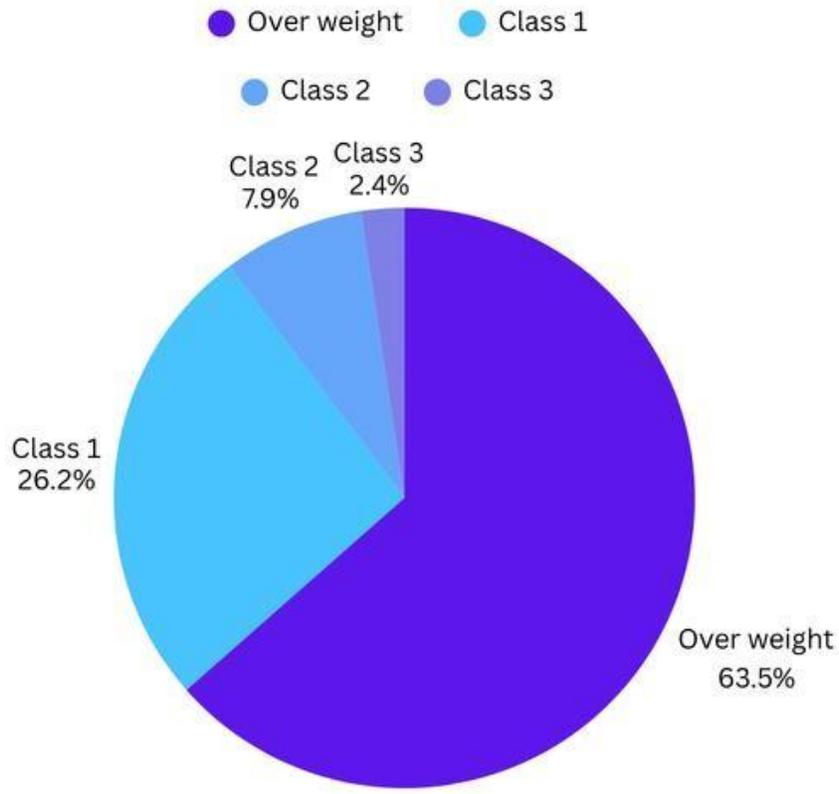**Table 3: Characteristics of DFU and its correlation with Obesity**

Characteristic	Frequency	Percentage	P-value

Margin			0.03
Regular	40	31.8	
Irregular	85	68.2	
Base color			0.446
Black	12	9.5	
Pale	19	15.9	
Red	94	74.6	
Odor			0.785
Odorless	26	20.6	
Foul smelling	99	79.4	
Discharge			0.673
None	9	7.1	
Serous	86	69	
Purulent	30	23.8	
Outcomes			0.05
Healing	102	81	
Amputation	23	19	
Duration of ulcer			
More than 1 month	80	64	0.016
Less than 1 month	45	36	

Bar chart 1: DFUs according to Wagner grade.
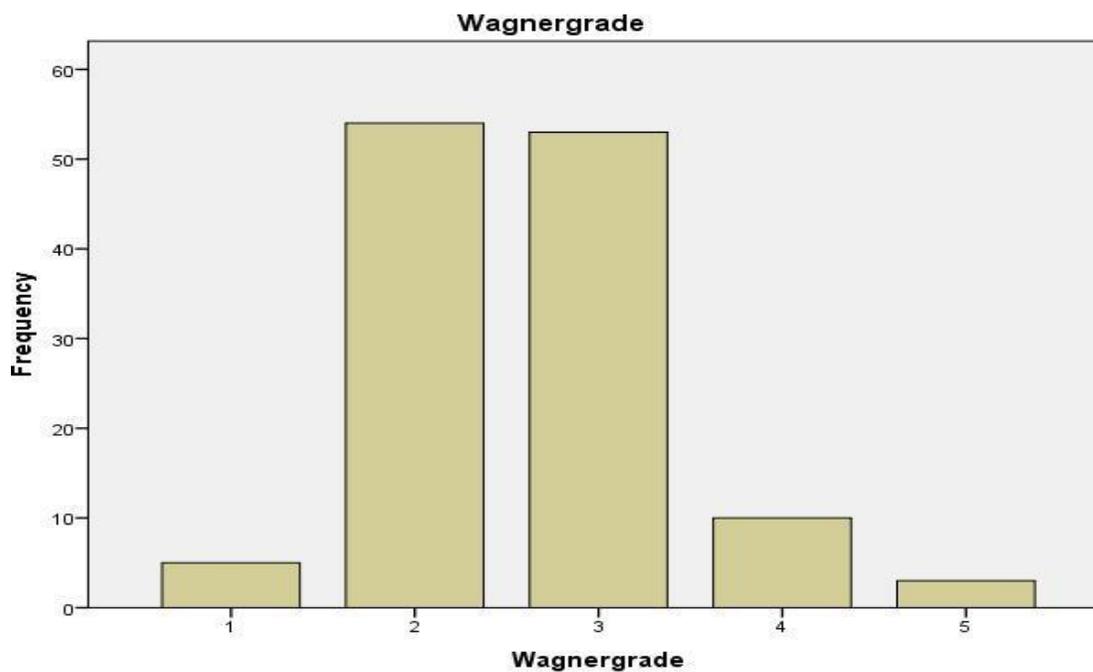
DISCUSSION:

According to Mariam TG et. Al obese diabetic patients were 2.65 times more likely to develop diabetic foot ulcers as compared to those diabetic patients who were not obese [AOR = 2.65; 95% CI: 1.25, 5.83][12]. This is consistent with the studies conducted in Ethiopia[13] and Kenya[14]. As the most severe diabetic complication, recent meta-analyses have shown that BMI>24.5 is an independent risk factor for new-onset DFU[15]. The relationship between BMI and diabetes is tightly linked through insulin resistance and mechanical stress with increasing vascular complications[16]. The research also found that the effect of BMI increasing the risk of DFU is more pronounced in males compared with females. This finding is consistent with previous observational studies, where obese males were identified as an independent risk factor for new-onset DFU and associated with amputation risk[17-18].

From the findings of this study, we are of the opinion that obesity has a link with duration of ulcer formation, outcomes following surgical management as well as having an impact on the relative shape of the ulcer. Most patients who were not obese had ulcers with irregular margins, however there was no significant contradiction in terms of odor, color of the base and the type of discharge. The possible reason could be due to the presence of higher foot pressure in those heavily weighed and with higher body mass index (BMI) diabetic patients which might decrease intensively the normal blood circulation pattern at the lower extremities resulting in the development of a larger ulcer with thicker edges and depth. Majority of the patients had DFUs with a red base and were odorless. Fairly, we can comment that obesity has no noticeable effect on granulation tissue formation as well as increasing the risk of superimposed infections.

As far as outcomes are concerned, patients who were overweight but not obese according to WHO classification had the ulcer for less than a month showing a positive response with wound healing following one to two sessions of debridement, daily washes and dressings. Among those who were obese, 23 patients had to undergo some sort of amputation in the form of ray, midtarsal or trans metatarsal amputation. Although a 2017 meta-analysis study has noted that "the contribution of obesity to the risk of diabetic foot ulceration is inconclusive,"[19] research by Zubair et al in India showed a positive correlation between ulcer duration and BMI, and amputation rate and BMI[20]. Although this is still a subject for debate, because of Biasucciet al[21] who reported wound healing in obese patients was better because there was an increase in endothelial progenitor cell levels that function as a protective vascular factor against atherosclerosis.

Our sample may not have been representative of all the diabetic patients attending the tertiary care setup of the province. There might be recall bias or reporting bias regarding control of the contributing factors, such as smoking frequency, co-morbid conditions like hypertension, level of education and proper address (rural vs urban). Further, the cross-sectional nature of the study does not confirm the definitive cause and effect relationship. In addition, the study has used a small sample size in a single center. Multicentric trials, with a larger sample size, if conducted in the future, may provide more convincing evidence.

CONCLUSION:

Based on the results of the research and discussion conducted, it can be concluded that there is a correlation between the degree of DFU according to Wagner's classification with diabetic duration and a higher body mass index (BMI). Encouraging overweight patients to reduce their BMI should contribute to reducing the risk of DFU. Provision of special emphasis from health care providers

for rural residence, decreasing excessive weight gain, managing neuropathy, and promoting foot self-care practice would decrease diabetic foot ulcers.

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