

THE RELATIONSHIP OF OBESITY TO DIABETIC FOOT ULCER IN TYPE 2 DIABETES MELLITUS PATIENTS

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Abstract:

Diabetes mellitus is a group of metabolic diseases, the common finding of which is elevated blood glucose levels, known as hyperglycemia. Severe hyperglycemia causes classic symptoms such as polyuria, polydipsia, and polyphagia and unexplained weight loss. This study used an observational descriptive analytic method with a cross sectional design to 42 respondents of type 2 Diabetes mellitus patients at PKU Muhammadiyah Gamping Hospital. The blood sugar levels, HbA1C, height, weight and incidence of diabetic foot ulcers were recorded. Data analysis used the Chi-Square test to see the relationship between obesity and the incidence of diabetic foot ulcers in patients with type 2 diabetes mellitus. The results of the study on 42 respondents showed that there were 31 Diabetes mellitus patients with diabetic foot ulcers (73.8%) while 11 people (26.2%). There were 21 male patients (50%) and 21 female patients (50%). A total of study subjects with normal Body Mass Index had type 2 diabetes mellitus with complications of diabetic foot ulcers (77.8%), 13 study subjects with overweight Body Mass Index experienced type 2 diabetes mellitus with complications of diabetic foot ulcers (61.9%), 11 study subjects with Body Mass Index obese class 1 had type 2 diabetes mellitus with complications of diabetic foot ulcers (91.7%). In patients with type 2 diabetes mellitus without complications of diabetic foot ulcers with normal Body Mass Index, there were 2 people (22.8%). In patients with type 2 diabetes mellitus without complications of diabetic foot ulcers with Body Mass Index overweight, there were 8 people (38.1%). Then in patients with type 2 diabetes mellitus without complications of diabetic foot ulcers with Body Mass Index obesity class 1 obtained 1 person (8.3%). The Chi-Square test was performed and the p value = 0.166. There is no significant relationship between obesity and the incidence of diabetic foot ulcers in patients with type 2 diabetes mellitus.

Keywords: Diabetes mellitus; Diabetic foot ulcer; Obesity

Introduction

Diabetes mellitus can occur when there is an increase in glucose levels in a person's blood because the body cannot produce or sufficient insulin or cannot effectively bind insulin to its receptors in various tissues (insulin resistance). Insulin is an important hormone produced in the pancreas. Insulin is a hormone needed to convert sugar, starch, and other foods into energy, causing persistent high blood sugar.¹ Insulin is also important for protein and fat metabolism. The inability of cells to respond, causing high blood glucose levels (hyperglycemia), which is a clinical indicator of diabetes, if left unchecked in the long term, can lead to various complications.²

In 2016, there were 1.6 million deaths caused by Diabetes Mellitus, making it the 7th leading cause of death globally.³ As many as 26.4% of the 261.1 million population in Indonesia in 2016 died from diabetes.⁴ In Indonesia, the highest prevalence of diagnosed DM was in the provinces of DKI Jakarta (3.4%), DIY (3.1%), East Kalimantan (3.1%), North Sulawesi (3%) and East Java (2.6%). The prevalence of DM in 2018 increased by 2% compared to 2013.⁵ DM poses a major threat to human health as well as a large socio-economic burden for governments.⁶ Therefore, DM needs special attention.

There are two factors that cause the high incidence of DM, namely patient factors, which can be controlled and risk factors, which cannot be controlled.⁷

Risk factors that cannot be controlled are race and ethnicity, age, gender, family medical history of diabetes mellitus, history of giving birth to babies weighing more than 4000 grams, and history of low birth weight less than 2500 grams. unhealthy lifestyle, obesity, lack of physical activity, impaired blood glucose levels, and smoking.⁸

Uncontrolled DM in the long term will cause various kinds of complications. Complications can be acute and chronic. Acute complications include hypoglycemia, diabetic ketoacidosis (DKA), and hyperglycaemic hyperosmolar state (HHS). While the chronic complications of diabetes are broadly divided into microvascular and macrovascular. Microvascular complications include neuropathy, nephropathy, and retinopathy, while macrovascular complications include cardiovascular disease, stroke, and peripheral arterial disease (PAD).⁹ In line with this, uncontrolled and untreated DM is reported to cause several complications such as increased blood coagulation, diabetic retinopathy, hypertension, chronic kidney disease, or foot ulceration, and significantly reduces patient productivity and life expectancy.¹⁰ In fact, DM is one of the diseases that is recognized as one of the main causes of death and disability worldwide.¹¹

Obesity is defined as abnormal and excessive fat accumulation that can interfere with health and can also generally be defined based on the 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.¹²

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.¹³ Similar studies suggest that obesity is a major contributing factor to insulin resistance and type 2 diabetes mellitus.⁹ Glycemic control is associated with a reduced risk of microvascular and macrovascular complications of diabetes mellitus.¹⁴

Diabetic foot ulcers are defined as ulcerated and infected feet associated with

neuropathy and/or peripheral arterial disease of the lower limbs in patients with diabetes.¹⁵ The diagnosis of diabetic foot ulcers is based on a history of diabetes mellitus, symptoms of neuropathy or peripheral arterial disease (PAD) and the presence of ulcerations in the feet. It is reported that about 15% of all diabetics will develop a foot ulcer during their lifetime.¹⁶ Diabetic foot ulcers increase morbidity in diabetic patients, leading to an increase in the number of outpatient and emergency room visits and hospitalization days with a greater risk of osteomyelitis and amputation.¹⁷

There are several risk factors as follows: gender (male), duration of diabetes more than 10 years, advanced age of the patient, high body mass index, and other comorbidities such as retinopathy, diabetic peripheral neuropathy, peripheral vascular disease, glycosylated hemoglobin levels (HbA1c), foot deformity, high plantar pressure, infection, and improper foot care habits.^{18–20} Therefore, special attention to foot care should be the main focus in the management of patients with diabetes to ensure that DFU can be prevented.²¹

DFU treatment is essential to prevent further damage from ulceration²². This is because DM patients with diabetic foot ulcers, mostly experience stress, depression and anxiety. They also have financial burdens, feel helpless, blame themselves and feel there is uncertainty in their lives.^{23–25}

Examination of the ulceration based on the depth, edge, shape and size to determine the severity of the ulcer and the treatment that the patient will receive.²⁶ 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.

The likelihood of neurogenic damage expressed by changes in sensory thresholds is

independent of glucose levels but is associated with hyperinsulinemia and insulin sensitivity. Following an increase in the sensory threshold shown in some obese individuals it is thought to be due to specific metabolic changes, potentially leading to peripheral neuropathy and diabetic foot ulcers.²⁷

Therefore, this study was conducted to determine the relationship between obesity and the incidence of diabetic foot ulcers in patients with type diabetes mellitus 2.

Research Method

The research design used in this study was analytic observational with a cross sectional approach. The sample was 42 patients with type 2 diabetes mellitus with or without complications of diabetic foot ulcers based on medical records at PKU Muhammadiyah Gamping Hospital with exclusion criteria for type 2 diabetes mellitus patients with or without complications and inclusion criteria for incomplete medical record data from the required variables.

This study began with the collection of secondary data in the form of medical records of patients with type 2 diabetes mellitus or without complications of diabetic foot ulcers according to the inclusion and exclusion criteria. The data are then categorized by gender, BMI, and the incidence of diabetic foot ulcers. Then statistical tests were carried out using SPSS software with a Chi Square unpaired comparative test and using the Fisher Test if the Chi Square conditions were not met. Data were expressed with 95% confidence interval ($p < 0.05$). This research has submitted an application for ethical clearance to the ethics committee of the Faculty of Medicine and Health Sciences UMY and has been approved with the number 022/EC-EXEM-KEPK FKIK UMY/III/2021.

Results

Respondents' distribution based on gender resulted 21 male respondents (50%) and 21 female respondents (50%) from the total of 42 respondents. The proportions of the research samples are 50% each and there is no significant difference.

Table 1. Respondents' distribution based on BMI

BMI	Frequency	%
Normal	9	21.4
Overweight	21	50.0
Obesity class 1	12	28.6
Total	42	100

From the research data in Table 1, the highest proportion of type 2 diabetes mellitus

patients was overweight, as many as 21 people (50%). Then there were 12 people with class 1 obesity (28.6%) and 9 people with normal BMI (21.4%). BMI calculation is based on height (m) and weight (kg), then the BMI calculation results are classified according to WHO.

From the research data, it was found that there were 31 patients with diabetes mellitus type 2 with diabetic foot ulcer complications (73.8%); while 11 people (26.2%) found without it. In this study, patients were hospitalized and found that the most common complications encountered in the last 3 years were patients with ulcers and patients with kidney failure.

Table 2 The Relationship of Obesity to the Incidence of Diabetic Foot Ulcers

BMI	Diabetic Foot Ulcer Incidence		Total	p-value
	DM with Ulcer frequency	DM without Ulcer frequency		
Normal	7 (77,8%)	2 (22,8%)	9	0,166
Overweight	13 (61,9%)	8 (38,1%)	21	
Obesity class 1	11 (91,7%)	1 (8,3%)	12	
Total	31 (73,1%)	11 (26,9%)	42	

From Table 2, it was found that 7 study subjects with normal BMI had type 2 diabetes mellitus with complications of diabetic foot ulcers with a percentage of 77.8%. Then 13 study subjects with overweight BMI experienced type 2 diabetes mellitus with complications of diabetic foot ulcers with a percentage of 61.9%. Then 11 research subjects with BMI obesity class 1 experienced type 2 diabetes mellitus with complications of diabetic foot ulcers with a percentage of 91.7%. In patients with type 2 diabetes mellitus without complications of diabetic foot ulcers with normal BMI, there were 2 people with a percentage of 22.8%. Then in patients with type 2 diabetes mellitus without complications of diabetic foot ulcers with overweight BMI, there were 7 people with a percentage of 38.1%.

Then in patients with type 2 diabetes mellitus without complications of diabetic foot ulcers with BMI obesity class 1 obtained 1 person with a percentage of 8.3%. The results of the analysis using the Chi-Square test obtained p value 0.166. Because p value > 0.05, so H_0 is accepted, and it can be concluded that there is no relationship between obesity and the incidence of diabetic foot ulcer complications.

Discussion

In this study, it showed that there was no significant relationship between obesity and the incidence of diabetic foot ulcers in patients with type 2 diabetes mellitus. In patients with type 2 diabetes, where in the study it was stated that obesity can affect the severity of diabetic foot ulcers in patients with

type 2 diabetes with risk factors for poor self-care resulting in limited flexibility and inability to care for, or inspect their feet every day.²⁸

In this study, obesity did not have a significant relationship with the incidence of diabetic foot ulcers in type 2 diabetes mellitus patients, because there were several other factors that were more influential in causing ulcers than obesity. Neuropathic factors have a strong relationship with foot ulcers in diabetic patients. Diabetic patients who had neuropathy were 21.7 times more likely to develop diabetic foot ulcers compared to diabetic patients without neuropathy. Peripheral neuropathy causes vasomotor paresis resulting in arteriovenous dysfunction of the subcutaneous vascular tissue. In addition, sweat secretion becomes dysfunctional by vasomotor paresis. Non-functioning sweat causes a lack of moisture and cooling through evaporation. As a result, the skin on the feet dries with a consequent reduction in the protective function of the skin and thus increases the risk of injury.²⁹ On environmental factors, it was found that diabetic patients living in rural areas were 2.57 times more likely to develop diabetic foot ulcers than diabetic patients from urban areas.

Diabetic patients who live in rural areas often spend most of their time in agricultural areas or outdoors and can experience injuries to their feet as a result of animal bites. Wounds on the feet of diabetics can lead to the development of ulcers due to poor wound healing and lack of health care opportunities. Another possible explanation is that diabetic patients living in rural areas have poor awareness of personal hygiene and foot care practices, and they often walk barefoot. This can expose their feet to harm and lead to the development of diabetic foot ulcers.³⁰

Conclusions

Based on the results of the research and discussion conducted, it can be concluded that there is no significant difference between obesity and the occurrence of diabetic foot ulcers in type 2 diabetes mellitus patients with p value = 0.166 and OR = 1.313.

In this study, there are still a lot of incomplete medical record data, it is hoped that the medical record officer at PKU Muhammadiyah Gamping Hospital can do a complete record. In addition, this study still uses a small number of samples and only in 1 place, furthermore it may be possible to develop a larger number of samples and from various places in order to achieve maximum results.

References

1. Chaudhary N, Tyagi N. Diabetes mellitus: An Overview. *Int J Res Dev Pharm L Sci*. 2018;7(4):3030-3033. doi:10.21276/IJRDPL.2278-0238.2018.7(4).3030-3033
2. International Diabetes Federation. *IDF Diabetes Atlas*.; 2019. https://diabetesatlas.org/idfawp/resource-files/2019/07/IDF_diabetes_atlas_ninth_edition_en.pdf
3. WHO. *Global Report on Diabetes*.; 2016.
4. WHO. *WHO Health Statistic : Monitoring Health for the SDGs, Sustainable Development Goals*.; 2018.
5. Badan Penelitian dan Pengembangan Kesehatan Kementerian RI. *Riset Kesehatan Dasar 2018*.; 2018.
6. Gao Y, Wang Y, Zhai X, et al. Publication trends of research on diabetes mellitus and T cells (1997–2016): A 20-year bibliometric study. *PLoS One*. 2017;12(9). doi:doi.org/10.1371/journal.pone.0184869

7. Bestari IL. Characteristics Of Patients with Type 2 Diabetes Mellitus At Surabaya Haji General Hospital. *Indones J Public Heal*. 2020;15(3):286-294.
8. Fatimah RN. Diabetes Melitus Tipe 2. *J Major*. 2015;4(5):93-101.
9. Papatheodorou K, Banach M, Bekiari E, Rizzo M, Edmonds M. Complications of Diabetes 2017. *J Diabetes Res*. 2018;2018. doi:10.1155/2018/3086167
10. Pham TB, Nguyen TT, Truong HT, et al. Effects of Diabetic Complications on Health-Related Quality of Life Impairment in Vietnamese Patients with Type 2 Diabetes. *J Diabetes Res*. 2020;2020. doi:10.1155/2020/4360804
11. WHO. *The Top 10 Causes of Death*.; 2018.
12. Jameson JL, Fauci AS, Kasper DL, Hauser SL, Longo L, Loscalzo J. *Harrison's Principles of Internal Medicine*. McGraw-Hill Education; 2018.
13. Daniel S, Soleymani T, Garvey WT. A complications-based clinical staging of obesity to guide treatment modality and intensity. *Curr Opin Endocrinol Diabetes Obes*. 2013;20(5):377. doi:10.1097/01.MED.0000433067.01671.F5
14. Vlad I, Oieru DS, Popa AR, Zaharia M. Long Term Complications Of Diabetes – A Review. *Rom J Diabetes Nutr Metab Dis*. 2014;21(4). doi:10.2478/rjdnmd-2014-0042
15. Lauterbach S, Kostev K, Kohlmann T. Prevalence of diabetic foot syndrome and its risk factors in the UK. <http://dx.doi.org/10.12968/jowc201019877711>. 2013;19(8):333-337. doi:10.12968/JOWC.2010.19.8.77711
16. Khan Y, Khan MM, Farooqui MR. Diabetic foot ulcers: a review of current management. *Int J Res Med Sci*. 2017;5(11):4683-4689. doi:http://dx.doi.org/10.18203/2320-6012.ijrms20174916
17. Alrub AA, Hyassat D, Khader YS, Bani-Mustafa R, Younes N, Ajlouni K. Factors associated with health-related quality of life among Jordanian patients with diabetic foot ulcer. *J Diabetes Res*. 2019;2019. doi:10.1155/2019/4706720
18. Waaijman R, De Haart M, Arts MLJ, et al. Risk factors for plantar foot ulcer recurrence in neuropathic diabetic patients. *Diabetes Care*. 2014;37(6):1697-1705. doi:10.2337/DC13-2470
19. Bortoletto MSS, De Andrade SM, Matsuo T, Haddad MDCL, González AD, Silva AMR. Risk factors for foot ulcers--a cross sectional survey from a primary care setting in Brazil. *Prim Care Diabetes*. 2014;8(1):71-76. doi:10.1016/J.PCD.2013.04.003
20. Jalilian M, Sarbarzeh PA, Oubari S. Factors Related to Severity of Diabetic Foot Ulcer: A Systematic Review. *Diabetes, Metab Syndr Obes Targets Ther*. 2020;13:1835-1842. doi:10.2147/DMSO.S256243
21. Ibrahim AM. Diabetic Foot Ulcer: Synopsis of the Epidemiology and Pathophysiology. *Int J Diabetes Endocrinol*. 2018;3(2):23-28. doi:10.11648/j.ijde.20180302.11
22. Anugerah A, Sulistyo H. Management of Diabetic Foot Ulcer: A Literature Review. *J Keperawatan Indones*. 2018;21(2):84-93. doi:10.7454/JKI.V21I2.634
23. Alfaqih MR, Kusnanto K, Padoli P. A Systematic Review: The Experience of Patient with Diabetic Foot Ulcers. *J Ners*. 2020;15(1Sp):120-128. doi:10.20473/JN.V15I1SP.18995
24. Winkley K, Sallis H, Kariyawasam D, et al. Five-year follow-up of a cohort of people with their first diabetic foot ulcer: The persistent effect of depression on mortality. *Diabetologia*. 2012;55(2):303-310. doi:10.1007/S00125-011-2359-2/FIGURES/2

25. Williams LH, Rutter CM, Katon WJ, et al. Depression and Incident Diabetic Foot Ulcers: A Prospective Cohort Study. *Am J Med*. 2010;123(8):748-754.e3. doi:10.1016/J.AMJMED.2010.01.023
26. Singh S, Pai DR, Yuhhui C. Diabetic Foot Ulcer-Diagnosis and Management. *Clin Res Foot Ankle* 2013 13. 2013;1(3):1-10. doi:10.4172/2329-910X.1000120
27. Smith AG, Singleton JR. Obesity and hyperlipidemia are risk factors for early diabetic neuropathy. *J Diabetes Complications*. 2013;27(5):436-442. doi:10.1016/J.JDIACOMP.2013.04.003
28. Chin YF, Liang J, Wang WS, Hsu BRS, Huang TT. The role of foot self-care behavior on developing foot ulcers in diabetic patients with peripheral neuropathy: a prospective study. *Int J Nurs Stud*. 2014;51(12):1568-1574. doi:10.1016/J.IJNURSTU.2014.05.001
29. Deribe B, Woldemichael K, Nemera G. Prevalence and Factors Influencing Diabetic Foot Ulcer among Diabetic Patients Attending Arbaminch Hospital, South Ethiopia. *J Diabetes Metab*. 2014;5:1. doi:10.4172/2155-6156.1000322
30. Bakri FG, Allan AH, Khader YS, Younes NA, Ajlouni KM. Prevalence of Diabetic Foot Ulcer and its Associated Risk Factors among Diabetic Patients in Jordan. *J Med J*. 2012;46(2):118-125.

