JURNAL ILMIAH ILMU KEPERAWATAN INDONESIA
Indonesian Nursing and Scientific Journal

Research Article
Analysis Of Factors Affecting Feet Sensitivity Disorders In Type 2 Diabetes Mellitus Patients

Indhit Tri Utami[1], Fitri Annisa[2]
Akademi Keperawatan Dharma Wacana
Jl. Kenanga No.3, Mulyojati, Kec. Metro Bar, Kota Metro, Lampung
Email Corespondent : indhitutami19@gmail.com

Conflict of interest statement: This research is free from conflicts of interest both personal and organizational.

Abstrak

Background: Diabetes mellitus is a disease that accounts for the highest number of deaths in the world with complications of microangiopathy that cause sensitivity to the feet. The occurrence of impaired foot sensitivity in patients is the most common and serious condition in Type 2 Diabetes Mellitus.
Objective: This study aims to find out the dominant factors among the variables of age, gender, long-suffering from DM, smoking history, and hypertension. This research was conducted at Tejo Agung Lampung Health Center.
Methods: The sample in this study amounted to 36 respondents with *purposive e*sampling. Impaired foot sensitivity is performed through the *Ipswich Touch Test* (IpTT) technique. Bivariate analysis uses the Spearman Rank test and multivariate analysis uses logistic regression tests
Result: showed that age is the dominant factor in the occurrence of impaired foot sensitivity with a value of 0.002. Multivariate analysis through regression equations obtained an equation value of 8.5%. This means that if a Type 2 DM patient is ≥ 50 years old and suffers from hypertension, then at risk of 8 times experiencing impaired leg sensitivity.
Conclusion: This study is expected to provide education and monitoring in DM patients to perform foot examinations so as to prevent complications such as diabetic ulcers.

Keywords: diabetes, *Ipswich Touch Test,* sensitivity

Introduction

Diabetes Mellitus (DM) currently accounts for the highest mortality rate worldwide. This is because DM is the leading cause of blindness, heart disease, and kidney failure. The International Diabetes Federation (IDF) estimates that the prevalence of diabetes will increase with age to 19.9% or 111.2 million people aged 65-79 years. DM is predicted to continue to increase until it reaches 578

million in 2030 and 700 million in 2045. Currently, the top three in the world are China, India, and the United States with 116.4 million, 77 million, and 31 million sufferers. Indonesia is ranked seventh among the 10 countries with the highest number of sufferers, which is 10.7 million people. Indonesia is the only country in Southeast Asia that is on the list of 10 countries with the highest number of diabetics in the world, so it can be estimated the magnitude of Indonesia's contribution to the prevalence of diabetes in Southeast Asia.[1]

The occurrence of impaired foot sensitivity in patients is the most frequent and serious complication in Diabetes Mellitus. The prevalence for the occurrence of impaired foot sensitivity is about 50%.[2] Sensitivity disorders are the third most common neurological disorders with an incidence of 54% of 100,000 people per year.[3] Research conducted by Rosyida in 2016 there were 113 patients with diabetic neuropathy in the Working Area of Kedungmundu Health Center Semarang. Research by Desnita in May 2016 there were 132 patients with impaired leg sensitivity who visited the Polyclinic Of Internal Medicine DR.M. Djamil Padang.

Persistent hyperglycemia increases the activity of the polyol pathway by the accumulation of glycation products of sorbitol, fructose, and advanced glycation end products (AGEs) that further damage the nerves. Increased blood sugar levels lead to increased production of enzymes such as aldose reductase and sorbitol dehydrogenase. This enzyme system will normally convert glucose to other forms, such as sorbitol and fructose until blood glucose levels are lower. Sorbitol, fructose, and glucose collect in the basal membrane of the cell and between cells.[4,5] The accumulation of sorbitol in the intracellular causes intracellular edema and affects function, where when there is a buildup of sugar, the synthesis of myoinositol nerve cells decreases which affects the conduction of the nerve itself.[4,5]

Some studies show the existence of several factors that cause impaired foot sensitivity. This sensivitasdisordercan be caused among others by age, gender, history of hypertension, long-suffering from DM, and smoking.[4] Assessment of the occurrence of vascular disorders and innervation is very important to prevent the occurrence of innervation disorder in the legs. This assessment should be done on every occasion of meeting with diabetic Mellitus. Both in hospitals and the community, nurses and other health teams focused only on lowering glucose levels in people with diabetes mellitus but never identified the extent of circulation disorders and peripheral sensations that occur in patients with diabetes mellitus, particularly type 2 diabetes mellitus.

Early detection of proper sensation disorders in patients with diabetes mellitus can reduce the occurrence of neuropathy or more severe complications, namely diabetic ulcers. Early detection of sensation disorders needs to be done by doing a simple examination. Neurological examination in this case examination of foot sensation can be done in various ways, one of which is through the Ipswich Touch Test.[6] The Ipswich Touch Test (IpTT) has a sensitivity of 81%, and a specificity of 94.6%. This means that the accuracy of the IpTT test in detecting neuropathy in diabetes by 81% and the accuracy of the test 94.6% in getting rid of people with DM who do not experience sensory disorders. The advantage of IpTT is that it can be taught to the Diabetisi family and does not need tools.[6,7] Based on the explanation above, the formulation of the problem in this study is what factors influence the incidence of feet sensitivity disorders in Type II Diabetes Mellitus patients?

Methods

This research was conducted from February to March 2021 at Tejo Agung Health Center of Lampung Province, Metro City. The sample in this study was all 36 people with DM who had full conscious patient inclusion, were able to mobilize freely, did not experience hearing loss, and were willing to be respondents. The criteria exclusion is having a diabetic ulcer, experiencing physical weakness, hypoglycemia, joint disorders, experiencing ALI (Acute Limb Ischemia), and being uncooperative.

Data collection tools used in the form of a question about the identity of patients include the name, age, gender, length of suffering from DM, smoking history, and history of hypertension, as

well as observation sheets on assessment of foot sensitivity through Ipswich touch test (IpTT). IpTT measurements are done by touching the tips of the toes without pressure and are very short. Point 1 is the right big toe, point 2 is the pinky of the right foot, point 3 is the left big toe, point 4 pinky of the left foot, point 5 of the middle finger of the right foot, and point 6 of the middle of the left foot. If the number of touches is felt at 5 to 6 points, then there is no disturbance in leg sensitivity but, if the patient does not feel touch at the number of points ≥ 2 points is considered adequate to infer any impaired foot sensitivity. The analysis of this study used multivariate analysis. Bivariate analysis uses the Spearman Rank test, while multivariate analysis uses the Logistic Regression test with the Backward method.

Results

Univariate analysis is used to look at the characteristics of respondents. Characteristics of respondents in this study included age, length of suffering from DM, history of smoking, gender, history of hypertension, and impaired leg sensitivity through IpTT assessment. The results of the univariate analysis are presented in the following table.

Table 1. Characteristics of Respondents based on Age, Length of Suffering from DM, smoking history, gender, and history of hypertension

Characteristic	Frequency	(%)
Age		
High Risk (≥50 years)	24	66,7
Low Risk (<50 years)	12	33,3
Gender		
Men	12	33,3
Woman	24	66,7
Long Suffering from DM		
High Risk (≥5 yrs)	20	55,6
Low Risk (<5 years)	16	44,4
History of Smoking		
Smoke	10	27,8
No smoking	26	72,2
History of Hypertension		
There's Hypertension	17	47,2
No hypertension	19	52,8
Foot Sensitivity		
There's a disturbance.	23	63,9
No distractions	13	36,1

In this study, respondents aged ≥ 50 years amounted to 24 (66.7%) and the age of < 50 years amounted to 12 people (33.3%). A person ≥ 45 years old is more at risk of developing DM compared to a < 45-year-old. This is in keeping with some epidemiological studies that the susceptibility of DM occurs in line with age. The aging process causes a decrease in the ability of pancreatic beta cells to produce insulin.[8] In the results of the study, the number of female respondents

was 24 people (66.7%) than the number of men, which was 12 respondents (33.3). Research conducted by Rita (2018) states that men are more likely to develop DM, but research conducted by Wahyuni (2014) women are at risk of DM because physically women have a greater chance of increasing body mass index due to monthly cycle syndrome (premenstrual syndrome). Post menopause makes the distribution of body fat becomes easily accumulated due to hormonal changes.

The number of respondents with DM ≥ 5 years is 20 people (55.6%) and long-suffering <5 years amounted to 16 respondents (44.4%). The results showed that the longer it suffered from DM, the longer the severity of DM.[9] Respondents who smoked in the study numbered 10 people (27.8%) and nonskiers 26 people (72.2%). Cigarettes have a relationship with dm events, where nicotine contained in cigarettes causes insulin resisitence.[10] In this study, the number of respondents who had hypertension amounted to 17 (47.2%) and those who were not hypertensive amounted to 19 people (52.8%). Hypertension is a risk factor for atherosclerosis. High blood pressure causes arteries to dilate and stretch excessively so that it can cause injury to the endothelial. Hypertension is a major risk factor for dm. Its relationship with type 2 DM is very complex, hypertension can make cells insensitive to insulin (insulin resistant). Loss of protective sensation of the legs resulted from chronic hyperglycemia that interferes with cell metabolism resulting in micro-macroangiopathy. This condition causes hypoxia. Hypoxia of nerve cells can cause myelinization and axon stasis in nerve cells and Schwann cells so that nerve delivery can be disrupted.[4, 11]

Tabel 2 : Factors-factors associated with impaired foot sensitivity

No.	Variable	IpTT Test		OR (CI 95%)	P-value
		Abnormal	Usual		
1	**Age** High Risk (≥50 years)	20 (87%)	4 (30,8)	15,000	0,002
	Low Risk (<50 years)	3 (13%)	9 (69,2%)		
2	**Gender** Men	10 (43,5%)	2 (15,4%)	4,231	0.177
	Woman	13 (56,5%)	11 (84,6%)		
3	**Long Suffering from DM** High Risk (≥5 years)	17 (73,9%)	3 (23,1%)	9,444	0,009
	Low Risk (<5 years)	6 (26,1%)	10 (76,9%)		
4	**History of Smoking** Smoke	9 (39,1%)	1 (7,7%)	7,714	0,102
	No smoking	14 (60,9%)	12 (92,3%)		
5	**History of Hypertension** There's Hypertension	15 (65,2%)	2 (15,4%)	10.313	0.011
	No hypertension	8 (34,8%)	11 (94,6%)		

The results of the analysis in Table 2 obtained a significance value of p-value = 0.002 < 0.05, so statistically, it is believed that there is a significant relationship between age and impaired

foot sensitivity. In the results of the analysis also obtained an Odds Ratio (OR) value of 15,000 (CI;95%) thus the age of ≥50 years is at risk of 15 times greater experiencing impaired leg sensitivity compared to people aged < 50 years.

Table 3. Multivariate Final Modeling

	Variable	B	Exp(B)	95% C.I.for EXP(B)	
				Lower	Upper
Step 4	Age	2.549	12.791	1.945	84.135
	HT History	2.150	8.584	1.173	62.831
	Constant	-7.577	.001		

The regression equation obtained is through the equation formula p = 1 / (1 +e-y)= 0.0805 = 8.5%. This means that if a Type 2 DM patient is ≥ 50 years old and suffers from hypertension, then at risk of 8 times experiencing impaired leg sensitivity.

Discussion

Age has an association for the occurrence of impaired foot sensitivity. In theory, increased age stimulates the process of degeneration and causes nerve cell damage.[4,8] Changes in both large nerve fibers and small nerve fibers give rise to susceptibility to sensitivity disorders. Reduced insulin resistance in the aging process has an impact on the occurrence of hyperglycemia, thus stimulating the production of oxidative free radicals called Reactive Oxygen Species (ROS) which results in blocking microvascular vasodilation.[4] Patients with DM are at high risk for having calcium deposits in the medial arteries, especially in the ankle arteries that cause the artery walls to become stiff causing ischemia and nerve damage.[12] This study is in line with those conducted by Mildawati, Diani &Wahid that there is a relationship between age and the incidence of neuropathy. Research conducted by Bansal et al (2014) also stated there is a relationship between age and neuropathy.

The longer a person has diabetes, the greater the risk of complications and the rate of foot sensitivity disorders. The results showed a long association of DM to the occurrence of sensitivity disorders in the legs with an odds ratio (OR) of 9,444 which means the length of DM ≥ 5 years is 9 times greater risk of peripheral sensitivity disorders. Research by Marisdina (2013) found an average length of suffering from DM for 5.21 years. Research conducted by Nisar et al (2015) there is a long-standing relationship of suffering from DM for more than 6 years has a risk of occurrence. peripheral sensitivity disorders.

Research conducted by Suri, M. H., Haddani, H., & Sinulingga (2018) there is no relationship between sex and impaired leg sensitivity. Both men and women have the same risk for impaired leg sensitivity. In this study, there was no association between sex and the occurrence of impaired leg sensitivity, although, the results showed that men are at risk of foot sensitivity disorders 4 times greater in women. The absence of an association in this study is due to the influence of many factors, which are factors that are not evaluated by researchers such as stress management, activity, blood sugar control.[13]

The study showed no association between a history of smoking with impaired leg sensitivity. However, based on the Odd Ratio (OR) value, respondents who have a history of smoking are at risk of 7 times experiencing sensation disorders. Nicotine affects the sympathetic nervous system that causes blood vessels to become vasoconstic.[10] Vasoconttion of blood vessels causes blood flow to the nerves to decrease, causing low myoinositol resulting in impaired sensation.[4] In this study, we explained the history of smoking. Therefore, respondents no longer smoke but have a history of smoking.

Hypertension has an association with the occurrence of foot sensitivity disorders in this study. Hypertension and TYPE 2 DM are two conditions that are related and trigger the emergence of each other. The relationship between DM and hypertension is explained by the onset of microvascular damage conditions, insulin resistance/ hyperinsulinemia, metabolic disorders, and increased sympathetic nerve activity. Hypertension is related to the occurrence of sensitivity disorders explained through microvascular conditions that undergohialinization lamina basal blood vessels that trigger the appearance of tombosis in intraneural arterial, blood flow to the nerves reduced then arise hypoxia and ischemia of nerve tissue, hypersensitization of peripheral neurons.[13,14]

Patients with diabetes are at high risk for having calcium deposits in the medial arteries, especially in the ankle arteries, which causes the arterial walls to stiffen. In hypertension, endothelial dysfunction occurs causing abnormalities in vascular smooth muscle tone, proliferation of vascular smooth muscle cells, impaired coagulation and fibrinolysis, and persistent inflammation, resulting in endothelial lesions which in turn cause tissue hypoxia and result in damage to nerve protein structures4,15. The results of multivariate final modeling using logistic regression showed that age was the dominant factor for the occurrence of foot sensation disorders. The regression equation obtained is through the equation formula $p = 1 / (1 + e^{-y}) = 0.0805 = 8.5\%$. This means that if a Type 2 DM patient is ≥ 50 years old and suffers from hypertension, then at risk of 8 times experiencing impaired leg sensitivity.

Conclusion

The study concluded that age, long-suffering from DM, and a history of hypertension have an association with impaired leg sensation. Variable sex and smoking history were not related to the occurrence of foot sensation disorders. Variable age is the dominant factor in the occurrence of foot sensation disorders in people with type 2 DM. Type 2 DM patients who are ≥ 50 years old and suffer from hypertension are at risk of 8 times experiencing impaired leg sensitivity.

Conlict of Interest Declaration
This research is free from conflicts of interest both personal and organizational.

Acknowledge
Not mentioned

Funding
Sources of funding in this study using personal funds.

References
1. Kemenkes RI.(2020). Infodatin Tetap Produktif, Cegah, dan Atasi Diabetes Melitus. Jakarta:Pusat Data dan Informasi Kementrian Kesehatan RI.
2. Juster-Switlyk, K., & Smith, A. G. Updates in diabetic peripheral neuropathy. F1000Research, 2016; 5.https://*doi*.org/*10.12688*/*f1000research*.*7898.1*
3. Battula, P., Afreen, S., Meena, E., Reddy, S. S. R., & Sujatha, G. Prevalence of sensory peripheral neuropathy in diabetic patients at diabetes care centre: a cross sectional study. Int J Res Med Sci, 2017;5(9), 4066. https://dx.doi.org/10.18203/2320-6012.ijrms20173984
4. Setiati, S. Buku Ajar Ilmu Penyakit Dalam Jilid II Edisi VI. Jakarta: Interna Publishing. 2015
5. Aekplakor W, et al. Prevalence and management of diabetes and metabolic risk factors in Thai adults. Diabetes Care Sep 2011; 34(9); ProQuest pg. 1980. https://doi.org/10.2337/dc11-0099
6. Rayman, G., Vas, P.R., Baker, N., Taylor, C.G., Gooday, C., & Donohe, M. The Ipswich Touch Test: A Simple ad Novel Method to Identify Inpatient with Diabets at Risk of Foot Ulceration. 2011 Jul;34(7):1517-8. https://doi.org/10.2337/dc11-0156
7. Hapipah. (2016). Efektivitas Ipswitch Touch Test (IpTT) Terhadap Pemeriksaan Neuropati

8. Dafriani, P. Hubungan Obesitas dan umur dengan kejadian diabetes mellitus tipe II. Jurnal Kesehatan Medika Saintika, 2017:8(2).

9. Andayani, T.M., Ibrahim, M.I.M., & asdie, A.H. The association of diabetesrelated factor and quality of life type 2 diabete mellitus. International Journal of Pharmacy and Pharmaceutical Sciences, 2010; 2 (1), 139-14.

10. Tuesta LM, et al. Recent advances in understanding nicotinic receptor signaling mechanisms thatregulate drug self-administration behavior. Biochem Pharmacol. 2011; 82:984–995. https://doi.org/10.1016/j.bcp.2011.06.026

11. Rosiani, Kadek Sri, Desak Made Widyanthari, and I. Wayan Surasta. Pengaruh Senam Kaki Diabetes Terhadap Neuropati Perifer Sensori Pada Pasien Diabetes Mellitus Tipe 2. (2018). https://doi.org/10.24843/coping.2021.v09.i03

12. Marumo, M, Ebara,S, Nishibe, I, Soneda, J,Wakabayashi, I. Relationships of age and gender with ankle-brachial systolic pressure index and cardio-ankle vascular index in patients with diabetes mellitus.*International Journal of Gerontology* 12.1 (2018): 32-36. https://doi.org/10.1016/j.ijge.2017.05.004

13. Yagihashi, S., Mizukami, H., Sugimoto, K. Mechanism of diabetic neuropathy: Where are we now and where to go?. Journal of Diabetes Investigation; 2011; 2(1): 1-13

14. Zychowska.M, Rojewska.E, Pizewiocka.B, Mika.J. Mechanisms and pharmacology of diabetic neuropathy-experimental and clinical studies. Institute of Pharmcology. Department of pain pharmacology. Polish academy of sciences. Poland.2013;1-10. https://doi.org/10.1016/s1734-1140(13)71521-4

15. Guyton & Hall. Buku Ajar Fisiologi Kedokteran Edisi Kedua belas. Singapura: Saunders Elseiver. 2011.