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Lifestyle-Based Quality Of Life Prediction Using Mathematical Modeling In Diabetic Neuropathy Patients

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Abstract

Background *: Diabetic neuropathy is one of the main complications of type 2 diabetes mellitus (type 2 DM). Diabetic neuropathy is one of the causes of decreased quality of life in type 2 DM sufferers. Prevention of decreased quality of life must be done early, so that something worse does not happen to the sufferer. One way is through controlling risk factors for decreasing quality of life, such as lifestyle.*

Objective *: The aim of this research was to form a mathematical model to predict quality of life based on lifestyle in diabetic neuropathy sufferers.*

Research Methodology *: This research was conducted using a cross sectional approach with 210 respondents. Respondents in the study were diabetic neuropathy sufferers who were selected using consecutive sampling techniques . Data collection was carried out using a valid and reliable questionnaire. Data analysis in this research was using logistic regression analysis.*

Research Results *: A mathematical model was obtained, namely Quality of life = 2.327 –3.475 (eating pattern) -3.420 (social interaction). Based on the Holmes and Lameshow Test values, the chi square value obtained is smaller and the table chi square value is (0.004 < 5.9915) and the p value is greater than the α value (0.998 > 0.05). Based on the area under curve (AUC) value, a value of 0.866 was obtained*

Conclusion *: The mathematical model that has been formed through this research can accurately predict the quality of life of diabetic neuropathy sufferers. This mathematical model consists of 2 predictor factors, namely eating patterns and social interactions. Model This form is accurate and strong in predicting quality of life both based on calibration parameters and also based on discrimination values*

Keywords *: quality of life, lifestyle, mathematical model, diabetic neuropathy.*

Introduction

Diabetes mellitus is a disease related to [1]uncontrolled blood sugar levels in a person due to decreased insulin function. The number of diabetes sufferers continues to increase significantly

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from year to year. In 2019 there were 463 million diabetes sufferers worldwide and 10.7 million in Indonesia (International Diabetes Federation, 2019) .

There are various complications that occur due to diabetes and the most frequent complication is diabetic neuropathy (Kumari et al., 2018) . According to the International Diabetes Federation at the international level, 16% to 87% of people with type 2 DM will experience peripheral neuropathy (International Diabetes Federation, 2019) . The same thing also happens at the national level, where 58% of type 2 DM sufferers suffer from peripheral neuropathy (Malik et al., 2020) .

Peripheral neuropathy is a disturbance in sensory, motor and autonomic nerve function caused by hyperglycemia at the edges of the body such as the tips of the feet or hands. The main clinical manifestations of peripheral neuropathy are pain, numbness, burning and cramping. Peripheral neuropathy is often also called painful diabetic neuropathy because the pain is the most common and severe problem felt by sufferers (Alam et al., 2017; Meijer et al., 2002) .

Peripheral neuropathy is a complication of diabetes mellitus which results in decreased quality of life for sufferers. This decrease in quality of life can occur in all aspects, especially the physical aspect. Impaired mobility, sleep disturbances, stress and decreased social function are problems that often arise in these sufferers. The worse the condition of the disease, the worse the sufferer's quality of life will be (AlSadrah, 2019; Sothornwit et al., 2018) .

Prevention of decreased quality of life from an early age must be carried out to obtain optimal quality of life in type 2 DM sufferers with peripheral neuropathy. Identifying every risk factor that is proven to have an influence on quality of life is the first step that can be taken. So by identifying risk factors for decreasing quality of life, appropriate interventions can be determined based on these risk factors.

There are several risk factors for decreased quality of life in peripheral neuropathy sufferers collected from various studies. These factors can be categorized into lifestyle factors consisting of smoking, lack of physical activity, diet and regularity of treatment. Characteristic factors of sufferers such as age, length of time suffering from DM, blood sugar levels, lipid levels. Comorbid disease factors such as hypertension (Khawaja et al., 2018; Liu et al., 2019; Pai et al., 2019; Papanas & Ziegler, 2015; Putri & Hasneli, 2020; Rahmawati & Hargono, 2018; Sohail et al., 2017; Su et al., 2018) (Ritonga et al., 2021) .

Among these factors, lifestyle factors are the factors with the most potential to be used as predictors of quality of life in type 2 DM sufferers with peripheral neuropathy. This is because lifestyle factors are one of the factors that can be modified, the main cause of diabetes mellitus and its complications and is one of the main management factors in managing diabetes mellitus itself (Perkeni, 2021) .

Lifestyle itself is a person's way and characteristics of living their daily life. Where this lifestyle is formed according to the special characteristics of geographical conditions, economic status, politics, culture and religion. Lifestyle consists of a person's behavior and function in work, entertainment, diet and other activities (Farhud, 2015) . In this research, 7 lifestyle components were selected for more in-depth research. These lifestyle components are physical activity, diet, sleep patterns, drinking sweet drinks, smoking, social interaction and self-care. Based on the explanation above, researchers are interested in examining the formation of mathematical models to predict lifestyle-based quality of life in diabetic neuropathy sufferers .

Methodology

The study design used was a cross-sectional design conducted in Padangsidimpuan City, North Sumatra Province. This research was carried out for 5 months, from May to September 2022.

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Respondents in this study were type 2 DM patients diagnosed by a doctor and had peripheral neuropathy as assessed using the Diabetic Neuropathy Score (DNS) instrument. Furthermore, respondents were selected by consecutive technique. The sample inclusion criteria used were not being in a state of anxiety and depression, not experiencing cognitive impairment, being able to communicate, being able to read and write, and being willing to follow all study procedures. the total number of respondents in this study was 210 people.

The study instrument used was developed by the team and has been tested for validity and reliability. The validity test was conducted by face, content, and construct validity. The reliability test used was internal consistency by considering the Cronbach alpha value. Data collection was carried out by distributing the research questionnaire to all respondents who met the existing criteria. After data collection was carried out, all research questionnaires were checked again to ensure completeness of the filling. The data that has been collected will be analyzed using a computer application, namely SPSS, and the data analysis used was logistic regression. This research has received ethical recognition from the Research Ethics Committee of the Faculty of Medicine, Andalas University with letter number 487/UN.16.2/KEP-FK/2021.

Results

Table 1. Characteristics of sex, ethnicity, marital status, unifying diseases, and diabetes mellitus (n=210)

No	Characteristics of Respondents	n	%
1	Gender		
	Man	99	47.1
	Woman	111	52.9
2	Ethnicity		
	Batak	131	62.4
	Mandailing	52	24.8
	Java	14	6,7
	Minang	13	6.2
3	Marital status		
	Not married yet	0	0.0
	Mary	143	68.1
	Widow or Widower	67	31.9
4	Concomitant Diseases		
	There is no	80	38.1
	Hypertension	78	37.1
	Strokes	2	1.0
	Respiratory disorders	4	1.9
	Heart Disorders	7	3.3
	Kidney disorders	1	0.5
	Visual Impairment	1	0.5
	Other	37	17.6
5	Long Suffering DM		
	Less than 5 years	113	53.8
	More than 5 years	97	46.2
	Amount	210	100.0

Source : calculated by authors

Based on table 1, 52.9% gender distribution of respondents indicates a predominance of women. Concerning respondents' ethnicity, 62.4% were identified as Batak and 68.1% were reported to be married. Furthermore, 38.1% did not have any co-morbidities, and 37.1% had hypertension as the most prevalent. Regarding the duration of DM, 53.8% reported having the condition for less than 5 years.

Table 2. Characteristics of Respondents Based on Age and Blood Sugar Levels

No	Characteristics of Respondents	Means	elementary school	Min	max
1	Age	53.31	8,624	31	73
2	Blood Glucose Levels	228.72	83,369	65	456

Source : calculated by authors

Based on table 2, the average age of respondents is 53.1 years, where many respondents have entered late adulthood. Furthermore, the average blood glucose level of the respondents was 228.72 mg/dl, which means that the blood glucose level of the respondents exceeded the normal limit.

Table 3. Bivariate Analysis of Predictor Factors with Quality of Life

Predictor Factors		Good QOL		Poor QOL		P value
		n	%	n	%	
physical activity	Good	4	1.9	0	0.0	0.292
	Bad	161	76.6	45	21.4	
Dietary habits	Good	87	41.4	10	4.7	0,000
	Bad	78	37.1	35	16.6	
Sleep Patterns	Good	67	31.9	11	5.2	0.047
	Bad	98	46.6	34	16.1	
Drink Sweet Drinks	Good	99	47.1	15	7.1	0.001
	Bad	66	31.4	30	14.2	
Smoke	Good	130	61.9	13	6.1	0,000
	Bad	35	16.6	32	15.2	
Social interaction	Good	125	59.5	12	5.7	0,000
	Bad	40	19.1	33	15.7	
Self-care	Good	99	47.1	20	9.5	0.062
	Bad	66	31.4	25	11.9	

Source : calculated by authors

Based on the table 3, there is 1 predictor factor that cannot be included in the multivariate examination, namely physical activity P-Value of 0.292. Predictor factors that can be continued into Multi-Carious Analysis are P-Value of less than 0.25.

Table 4. Logistic Regression Analysis

	B	S.E	Wald	DF	Sig
Dietary habits	-3,475	0.646	28,932	1	0,000
Social interaction	-3,420	0.649	27,812	1	0,000
Constant	2,327	0.616	14,293	1	0,000

Source : calculated by authors

Based on the table 4, there were 2 predictor factors influencing the quality of life, namely dietary habits and social interaction. The logistic regression analysis shows that a mathematical model of logistic regression can be formed, namely:

Quality of life = 2,327 – 3,475 (dietary habits) – 3,420 (social interaction)

Table 5. Equation Quality based on Calibration Parameters with Hosmer and Lameshow Test

steps	Chi-square	df	Sig.
1	5039	8	,753
2	3,783	8	,876
3	4,792	7	,685
4	2,248	5	,814
5	,004	2	,998

Source : calculated by authors

Based on the table 5, the Hosmer and Lameshow chi-square test values obtained were 0.004 < 5.9915 the value for DF 2. The significance value was obtained at 0.998 > 0.05 p-value, therefore, the model formed is correct.

Table 6. Quality of Equations based on Discrimination Values with AUC Curve Values (Area Under Curve)

areas	std. Errors [a]	Asymptotic Sig. [b]	Asymptotic 95% Confidence Intervals	
			LowerBound	UpperBound
,866	,029	,000	,810	,923

Source : calculated by authors
Based on the table 6, the AUC value was 0.866, meaning the result obtained was 86.6% as a statistically strong value.

Discussion

A model is a representation of an object or a simple description of an object that can be used in calculations. The model consists of a collection of propositions or statements that state the relationship between constructs which can be in the form of shape, size and style (OSTERWALDER, 2004) . The prediction model itself is a model that is formed based on statistical tests and can be used to predict events or results. Prediction models are carried out in the form of technological data collection which works by analyzing past or current data and producing models to help predict future results (Kalechofsky, 2016) . There are 2 factors that can predict quality of life, namely eating patterns and social interactions.

The application of dietary regulation for each person can be measured based on quantity food, the regularity of eating and the type of eating. Amount of food means how much food is consumed at each meal, both main meals and snacks. Eating regularity means the frequency of main meals 3 times a day and can also be accompanied by snacks 2 times a day. Type of food means the content and composition of the food consumed at each meal.

Setting a healthy eating pattern will help maintain ideal body weight. Food intake has a strong correlation with obesity (Sami et al., 2017) . However, the application of dietary regulation is still difficult to implement well in type 2 DM sufferers with peripheral neuropathy. Dietary

management in type 2 DM sufferers with peripheral neuropathy is worse than in type 2 DM sufferers without peripheral neuropathy (Gode et al., 2022) .

According to Ghavami et al., (2018) lifestyle interventions, one of which is regulating diet, can contribute to reducing the severity of peripheral neuropathy which will ultimately reduce the pain that occurs. This reduction in pain will ultimately contribute to improving the sufferer's quality of life. As explained at the beginning, pain is the main symptom of peripheral neuropathy.

According to D'Egidio et al., (2022), several studies have shown that food supplements can help overcome pain in type 2 DM sufferers with peripheral neuropathy. These supplements together with other pharmacological pain therapies can reduce the pain scale. Supplements can be defined as products that are used to support the main diet and that contain one or more of the following compounds, such as vitamins, minerals, herbs or other plants.

To achieve good dietary management, the knowledge aspect is the initial key that must be improved. Providing regular and ongoing health education can increase the knowledge of type 2 DM sufferers with peripheral neuropathy. This has been proven by various research results which show that a good level of knowledge will result in good dietary patterns. Efforts to increase knowledge of type 2 DM sufferers with peripheral neuropathy can be done through self-dietary management. Where the America Diabetes Association states that self-dietary management is a key step in providing DM sufferers with knowledge and skills in food management (Sami et al., 2017) .

The next predictive factor found in this research is social interaction. Social interaction plays a very important role in maintaining the quality of human life. The role of social interaction is even more important when someone feels lonely or has physical limitations and also loses income (Datta et al., 2015) . Type 2 DM sufferers with peripheral neuropathy are a disease that causes sufferers to experience immobilization. So they spend more time at home and rarely live a social life like they used to before suffering from this disease.

In diabetic neuropathy sufferers, it shows that social interaction has an influence on quality of life. This was conveyed by Maxwell et al., (2013) that social interactions have an influence on the quality of life of peripheral neuropathy sufferers. The mental aspect is the quality of life aspect that is most affected by this social interaction. The level of social interaction that can influence the quality of life in peripheral neuropathy sufferers is the same level in sufferers of other chronic diseases.

The emergence of various problems in sufferers' feet is the main cause of decreased social interaction. Problems with sufferers' feet consist of pain in the feet, numbness and tingling in the feet, all of which cause impaired mobility in type 2 DM sufferers with peripheral neuropathy which leads to poor social interactions. According to Wojtkiewicz et al., (2015) the appearance of pain in type 2 DM sufferers with peripheral neuropathy can trigger increased stress. This happens because type 2 DM sufferers with peripheral neuropathy rarely leave the house for activities such as social activities. This situation can also cause depression and increase coping mechanisms.

To increase the frequency and intensity of social interactions, this can be done by strengthening social relationships, especially social relationships with family, friends and fellow diabetes sufferers. Social relationships play a very important role in building social interactions. Where the social relationships that have been established between individuals help form effective social interactions. When two people meet and one of them can have a positive influence on the other, a positive social interaction has been formed. Furthermore, if this continues, a dynamic reciprocal relationship will be formed (Kitishat & Freihat, 2015) .

Taking advantage of the social relationships of those closest to you is the most sensible thing to do so that the sufferer's social interactions can be rebuilt. Illness conditions and existing limitations will usually reduce a person's desire to rebuild pre-existing social relationships. So that family and friends can provide positive support to sufferers so that they remain willing to interact with other people.

Another social relationship that must be rebuilt is with other people who have the same problems as the sufferer, such as the diabetes group. This special group will be a forum for sharing knowledge, experiences and venting. So that in the group there will be efforts to strengthen each other.

Apart from strengthening social relations, another effort that can be made is to utilize social media as a medium for social interaction. Social media is currently a new alternative for social interaction. Although the research results state that social media will not be able to replace social interaction in the real world, this effort can also increase the frequency of social interaction with other people. Social media is also widely said to show things that are very different from actual reality, but social media is also said to be able to influence social interactions (Yohanna, 2020) .

Research Limitations

This research has several limitations, namely that it is not known exactly how long it will take for the resulting predictions to actually occur. Apart from that, aspects of quality of life and lifestyle are subjective and will be closely related to the social and cultural factors of the sufferer. So the application of the results of this research is still limited to a certain group that has similarities to the population and sample criteria in this research.

Conclusion

The mathematical model that has been formed in this research consists of 2 factors, namely eating patterns and social interactions. The mathematical model that has been formed through this research can predict the quality of life of diabetic neuropathy sufferers. The mathematical model formed is precise and strong in predicting quality of life both based on calibration parameters and discrimination values

Bibliography

Alam, U., Fawwad, A., Shaheen, F., Tahir, B., Basit, A., & Malik, R.A. (2017). Improvement in Neuropathy Specific Quality of Life in Patients with Diabetes after Vitamin D Supplementation. Journal of Diabetes Research , 2017 . https://doi.org/10.1155/2017/7928083

AlSadrah, S.A. (2019). Impaired quality of life and diabetic foot disease in Saudi patients with type 2 diabetes: A cross-sectional analysis. SAGE Open Medicine , 7 , 205031211983209. https://doi.org/10.1177/2050312119832092

D'Egidio, F., Lombardozzi, G., Kacem Ben Haj M'Barek, H.E., Mastroiacovo, G., Alfonsetti, M., & Cimini, A. (2022). The Influence of Dietary Supplements on Neuropathic Pain. Life , 12 (8), 1–18. https://doi.org/10.3390/life12081125

Datta, D., Datta, P. P., & Majumdar, K. K. (2015). Original Article Role of Social Interaction on Quality of Life. National Journal of Medical Research , 5 (4), 290–292.

Farhud, DD (2015). Impact of lifestyle on health. Iranian J Public Health , 44 (11), 1442–1444. https://doi.org/10.1145/3177148.3180101

Ghavami, H., Radfar, M., Soheily, S., Shamsi, S.A., & Khalkhali, H.R. (2018). Effect of lifestyle interventions on diabetic peripheral neuropathy in patients with type 2 diabetes, results of a randomized clinical trial. Agri , 30 (4), 165–170. https://doi.org/10.5505/agri.2018.45477

Gode, M., Aga, F., & Hailu, A. (2022). Self-Care Practices Among Adult Type 2 Diabetes Patients With and Without Peripheral Neuropathy: A Cross-Sectional Study at Tertiary Healthcare Settings in Ethiopia. The Canadian Journal of Nursing Research = Revue Canadienne de Recherche En Sciences Infirmieres , 54 (3), 345–356. https://doi.org/10.1177/08445621211020653

International Diabetes Federation. (2019). IDF Diabetes Atlas Ninth. In World: IDF .

Kalechofsky, H. (2016). A Simple Framework for Building Predictive Models. A Little Data Science Business Guide , September , 6–17. http://www.msquared.com/wp-content/uploads/2017/01/A-Simple-Framework-for-Building-Predictive-Models.pdf

Khawaja, N., Abu-Shennar, J., Saleh, M., Dahbour, SS, Khader, YS, & Ajlouni, K.M. (2018). The prevalence and risk factors of peripheral neuropathy among patients with type 2 diabetes mellitus; The case of Jordan. Diabetology and Metabolic Syndrome , 10 (1), 1–10. https://doi.org/10.1186/s13098-018-0309-6

Kitishat, A. R., & Freihat, H. M. (2015). The Role of Social Relations in Successful Social Interactions and Language Acquisition. Research on Humanities and Social Sciences , 5 (4), 194–198.

Kumari, G., Singh, V., Jhingan, A.K., Chhajer, B., & Dahiya, S. (2018). Effect of lifestyle intervention on medical treatment costs and health-related quality of life in type 2 diabetes mellitus patients. Biomedical and Pharmacology Journal , 11 (2), 775–787. https://doi.org/10.13005/bpj/1432

Liu, X., Xu, Y., An, M., & Zeng, Q. (2019). The risk factors for diabetic peripheral neuropathy: A meta-analysis. PLoS ONE , 14 (2), 1–16. https://doi.org/10.1371/journal.pone.0212574

Malik, R.A., Andag-silva, A., Dejthevaporn, C., Hakim, M., Koh, J.S., Pinzon, R., Sukor, N., Wong, KS, & Asia, S. (2020). Diagnosing peripheral neuropathy in South-East Asia: A focus on diabetic neuropathy . 11 (5). https://doi.org/10.1111/jdi.13269

Maxwell, S. K., Barnett, C., Kokokyi, S., Leung, J. C., Yu, J. J., Bril, V., & Katzberg, H. D. (2013). Association of social support with quality of life in patients with polyneuropathy. Journal of the Peripheral Nervous System : JPNS , 18 (1), 37–43. https://doi.org/10.1111/jns5.12005

Meijer, J. W. G., Smit, A. J., Sonderen, E. V, Groothoff, J. W., Eisma, W. H., & Links, T. P. (2002). Symptom scoring systems to diagnose distal polyneuropathy in diabetes : the Diabetic Neuropathy . 962–965.

OSTERWALDER, A. (2004). THE BUSINESS MODEL ONTOLOGY A PROPOSITION IN A DESIGN SCIENCE APPROACH (Vol. 101, Issue 3) [Université de Lausanne Pour]. http://eprints.uanl.mx/5481/1/1020149995.PDF

Pai, Y. W., Lin, C. H., Lin, S. Y., Lee, I. Te, & Chang, M. H. (2019). Reconfirmation of newly discovered risk factors of diabetic peripheral neuropathy in patients with type 2 diabetes: A case-control study. PLoS ONE , 14 (7), 1–10. https://doi.org/10.1371/journal.pone.0220175

Papanas, N., & Ziegler, D. (2015). Risk factors and comorbidities in diabetic neuropathy: An update 2015. Review of Diabetic Studies , 12 (1–2), 48–62. https://doi.org/10.1900/RDS.2015.12.48

Perkeni. (2021). Guidelines for the Management and Prevention of Adult Type 2 Diabetes Mellitus in Indonesia 2021. In PB Perkeni . www.ginasthma.org.

Putri, AM, & Hasneli, Y. (2020). Factors That Influence the Severity of Peripheral Neuropathy Among Diabetes Mellitus Patients: Literature Review Factors Associated with Severity of Peripheral Neuropathy Among Diabetes Mellitus Patients: Literature Review Based on Health Research D.

Rahmawati, A., & Hargono, A. (2018). Dominant Factor of Diabetic Neuropathy in Diabetes Mellitus Type 2 Patients. Periodical Journal of Epidemiology , 6 (1), 60. https://doi.org/10.20473/jbe.v6i12018.60-68

Ritonga, SH, Julianda, DP, & Antoni, A. (2021). Diabetic Foot Problems Sufferers. Priority Nursing Journal , 4 (1), 1–8.

Sami, W., Ansari, T., Butt, N.S., Rashid, M., & Hamid, A. (2017). Effect Of Diet Counseling on Type 2 Diabetes Mellitus: A Review. International Journal of Health Sciences , 11 (2), 65–71. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5426415/pdf/IJHS-11-65.pdf

Sohail, S., Qadir, A., Ashraf, A., Ashraf, S. J., Serafi, S., & Hussain, Z. (2017). Prevalence of risk factors promoting diabetic neuropathy. International of Biological Research , 5 (1), 1–5.

Sothornwit, J., Srisawasdi, G., Suwannakin, A., & Sriwijitkamol, A. (2018). Decreased health-related quality of life in patients with diabetic foot problems. Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy , 11 , 35–43. https://doi.org/10.2147/DMSO.S154304

Su, J. bin, Zhao, L. hua, Zhang, X. lin, Cai, H. li, Huang, H. yan, Xu, F., Chen, T., & Wang, X. qin. (2018). HbA1c variability and diabetic peripheral neuropathy in type 2 diabetic patients. Cardiovascular Diabetology , 17 (1), 1–9. https://doi.org/10.1186/s12933-018-0693-0

Wojtkiewicz, D.M., Saunders, J., Domeshek, L., Novak, C.B., Kaskutas, V., & Mackinnon, S.E. (2015). Social impact of peripheral nerve injuries. Hand , 10 (2), 161–167. https://doi.org/10.1007/s11552-014-9692-0

Yohanna, A. (2020). The influence of social media on social interactions among students. Indonesian Journal of Social Sciences , 12 (2), 34. https://doi.org/10.20473/ijss.v12i2.22907