

## Factors Associated with Diabetic Peripheral Neuropathy among Patients with Type 2 Diabetes Mellitus in Surakarta, Central Java

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### ABSTRACT

**Background:** Peripheral neuropathy is the most common chronic complication and often occurs in diabetes mellitus. Peripheral neuropathy can cause morbidity, decreased quality of life, and mortality. This study aimed to analyze the determinants of peripheral neuropathy in patients with type 2 diabetes mellitus in Surakarta, Central Java.

**Subjects and Method:** This study was an observational analytic with cross-sectional design. This study was conducted at Surakarta Regional Hospital, Central Java on July 2019. A total of 200 type 2 diabetes mellitus outpatients was selected by simple random sampling. The dependent variable was peripheral neuropathy. The independent variables were age, education level, income, self-efficacy, diet, medication adherence, physical activity, health literacy, duration of illness, and fasting blood sugar. Peripheral neuropathy was measured using the Michigan Neu-Black Screening Instrument (MNSI). Other variable data were obtained using questionnaires. Analysis of data used multiple logistic regression.

**Results:** The risk of peripheral neuropathy increased with age of  $\geq 55$  years ( $b = 3.61$ ; 95% CI = 1.51 to 5.70;  $p = 0.001$ ), duration of illness  $\geq 5$  years ( $b = 2.78$ ; 95% CI = 0.51 to 5.04;  $p = 0.016$ ), and fasting sugar  $\geq 110$  mg / dL ( $b = 1.64$ ; 95% CI = -0.01 to 3.03;  $p = 0.052$ ). The risk of peripheral neuropathy decreased with education level  $\geq$  senior high school ( $b = -2.41$ ; 95% CI = -4.31 to -0.51;  $p = 0.013$ ), income  $\geq$  Rp 1,800,000 ( $b = -1.58$ ; 95% CI = -3.12 to -0.04;  $p = 0.044$ ), high self-efficacy ( $b = -1.67$ ; 95% CI = -3.26 to -0.07;  $p = 0.040$ ), controlled diet ( $b = -1.89$ ; 95% CI = -3.64 to -0.14;  $p = 0.034$ ), high medication adherence ( $b = -2.34$ ; 95% CI = -4.13 to -0.56;  $p = 0.010$ ), high physical activity ( $b = -2.33$ ; 95% CI = -4.17 to -0.49;  $p = 0.013$ ), and high health literacy ( $b = -1.52$ ; 95% CI = -3.18 to 0.14;  $p = 0.073$ ).

**Conclusion:** The risk of peripheral neuropathy increases with age of  $\geq 55$  years, duration of illness  $\geq 5$  years, and fasting blood sugar  $\geq 110$  mg/dL. The risk of peripheral neuropathy decreases with a high education level, income of  $\geq 1,800,000$ , high self-efficacy, controlled diet, high medication adherence, high physical activity, and high health literacy.

**Keywords:** peripheral neuropathy, diabetes

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### BACKGROUND

Diabetes mellitus (DM) is a very critical public health problem. A total of 425 million people suffer from diabetes. Indonesia ranks 6th in the world with 10.3 million DM sufferers (IDF, 2017). Diabetes ranks second as the biggest disease in Central Java with a prevalence of 19.22%

(Health Office of Central Java, 2017). Based on Surakarta's health profile diabetes is included in the 10 largest diseases in Surakarta (Surakarta health service, 2018).

Diabetes progressively progresses and is associated with a number of complications such as retinopathy, nephropathy, and neuropathy (Forbes and Cooper, 2013).

Neuropathy is a disorder of nerve activity throughout the body and can change autonomic, motoric, and sensory functions (IDF, 2017).

Peripheral neuropathy is the most common complication in DM. Peripheral neuropathy is a nerve disorder that affects the nerves of the distal limbs, especially the legs. Peripheral neuropathy can cause morbidity such as diabetic cancer, ulceration, infection, and amputation (IDF, 2017). About 8% of peripheral neuropathies occur in patients newly diagnosed with DM and more than 50% of peripheral neuropathies occur in patients who have been diagnosed long ago (Deli et al., 2013).

At least 200 million people with DM around the world have neuropathy. About 20 million Americans are estimated to currently have pre-diabetic neuropathy, type 1 diabetes, or type 2 diabetes (Feldman et al., 2017).

According to Soewondo (2013) about diabetes management in Indonesia, the prevalence of diabetes in Indonesia is quite high by 78% (Soewondo et al., 2013).

Risk factors for peripheral neuropathy include duration of diabetes, hyperglycemia, aging, hyperglycemia such as high fasting blood sugar, obesity, and low physical activity (Papanas and Ziegler, 2015). The highest prevalence of neuropathy is in people with poor blood glucose control (Callaghan et al., 2012).

Peripheral neuropathy also has a huge impact on the decreased quality of life of patients with DM. This is mainly due to weaknesses, ataxia, injury and other conditions (Vinik et al., 2013). DM patients with peripheral neuropathy also require more health care costs than DM patients without complications (Juster-Switlyk and Smith, 2016).

The high prevalence of peripheral neuropathy in type 2DM is an important

problem that must be resolved immediately using a model approach that is able to assess various factors. This study aims to analyze the determinants of peripheral neuropathy in type 2 diabetes mellitus patients.

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## SUBJECTS AND METHOD

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### 1. Design of the Study

This type of study was an observational analytic study with cross sectional design. This study was conducted in July 2019 at Surakarta Regional Hospital, Central Java.

### 2. Population and Sample

The population in this study were all type 2 diabetes mellitus outpatients in Surakarta Regional Hospital. A total of 200 patients were selected using simple random sampling technique.

### 3. Variables of the Study

The dependent variable in this study was peripheral neuropathy. The independent variables were age, education level, income, self-efficacy, diet, medication adherence, physical activity, health literacy, duration of illness, and fasting blood sugar.

**4. Operational Definition of Variables**  
**Peripheral neuropathy.** Peripheral neuropathy was a disorder of sensory nerve activity that affected the nerves of the distal limbs, especially the feet caused by diabetes mellitus.

**Age.** Age was the time of the respondent's existence from the beginning of birth until the time this study was conducted.

**Education.** The level of education was the highest level of formal education or the highest equivalent ever achieved by subjects of the study.

**Income.** Income was the average of maximum wage received by both formal and informal subjects, husband or wife within a period of one month based on the minimum wage in Surakarta.

**Self-efficacy.** Self-efficacy was the belief or confidence of subjects of the study regarding their ability to perform DM type 2 self-care behavior.

**Diet.** Diet was a statement of the subject on behavior or actions in carrying out nutritional therapy by medical personnel whether it is in accordance with the type, quantity, and eating schedule recommended in the self-care management of type 2 DM patients.

**Medication Adherence.** Adherence to a medication was a statement of the subject's behavior in receiving treatment therapy provided by health care providers. This was consisted of barriers related to drugs, barriers about the health care system, intentional barriers by subjects, and unintentional barriers by subjects of the study.

**Physical Activity.** Physical activity was the subject's statement about behavior in carrying out activities or physical exercises consisting of time spent while walking outdoors, time spent in practicing sports, and contributions to household chores.

**Health Literacy.** Health literacy was the subject's ability to find, understand, and assess health information obtained in daily life.

**The duration of illness.** The duration of illness was a statement of the subject for the duration or time of illness that had been suffered by the subject, starting from the time it was diagnosed by a doctor to when asked by the researcher.

**Fasting Blood Sugar.** Fasting blood sugar was a blood sugar level that was measured after the subject has been fasting for approximately 8 hours and stated in mg/dL units.

## 5. Instruments of the Study

Peripheral neuropathy data were obtained using Michigan Neuropathy Screening Instrument (MNSI). Other variable data

were collected using questionnaires. The questionnaires consisted of favorable and unfavorable questions. The instrument in the study used questionnaires that had been tested for validity and reliability.

## 6. Data Analysis

Univariate analysis was to see the frequency distribution and percentage characteristics of subjects of the study for categorical data, while continuous data was to see N, Mean, SD, Min, and Max. Bivariate analysis used Chi-square test and Odds Ratio. Multivariate analysis used multiple logistic regression.

## 7. Research Ethics

Research ethics included informed consent, anonymity, confidentiality, and ethical clearance. Ethical eligibility in this study came from the Medical Research Ethics Commission of the Faculty of Medicine, Universitas Sebelas Maret, Central Java, with number: 130/UN27.06/KEPK / 2019

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## RESULTS

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### 1. Sample Characteristics

Table 1 shows the average of subjects aged 55.92 years with a minimum age by 40 years and a maximum age by 76 years. The average income of Rp 1,595,000 with the lowest income of Rp 400,000 and the highest Rp 4,500,000. The average health literacy value was 11.57 with the lowest score was 3 and the highest was 21. The majority of self-efficacy had a value by 7.42 with the lowest value was 3 and the highest was 15. The average of medication adherence was 6.62 with the lowest value of 3 and the highest 13. The average of diet value was 14.82 with the lowest value by 4 and the highest by 32. The majority of physical activity had a value by 17.41 with the lowest value by 8 and the highest by 30. The average duration of illness was 5.49 years with the lowest duration by 1 year and the highest by 15 years. Fasting blood sugar

averaged was 143.66 mg/L with the lowest value by 85 mg / dL and the highest by 350 mg/dL. The average value of peripheral

neuropathy was 10.79 with the lowest value by 4 and the highest by 19.

**Table 1. Univariate Analysis (Continuous Data)**

Variable	n	Mean	SD	Min.	Max.
Age	200	55.92	9.03	40	76
Income	200	15.95	8.94	4	45
Health literacy	200	11.57	6.49	3	21
Efficacy	200	7.42	3.17	3	15
Mediation Adherence	200	6.62	2.93	3	13
Diet	200	14.82	7.79	4	32
Physical Activity	200	17.41	7.40	8	30
Duration of illness	200	5.49	3.11	1	15
Fasting blood sugar	200	143.66	55.54	85	350
Peripheral neuropathy	200	10.79	4.77	4	19

**Table 2. Univariate Analysis (Dichotomous Data)**

Variable	Criteria	Frequency(n)	Percentage (%)
Age	< 55 years	97	48.5
	≥ 55 years	103	51.5
Sex	Male	68	34.0
	Female	132	66.0
Education	Low	121	60.5
	High	79	39.5
Income	< Rp 1,800,000	113	56.5
	≥ Rp 1,800,000	87	43.5
Health literacy	Low	110	55.0
	High	90	45.0
Self-efficacy	Low	112	56.0
	High	88	44.0
Medication Adherence	Disobedient	116	58.0
	Obedient	84	42.0
Diet	Uncontrolled diet	107	53.5
	Controlled diet	93	46.5
Fasting blood sugar	< 110 mg/dL	89	44.5
	≥ 110 mg/dL	111	54.0
Physical activity	Not active	118	59.0
	Active	82	41.0
Duration of illness	< 5 years	77	38.5
	≥ 5 years	123	61.5
Peripheral neuropathy	No Peripheral Neuropathy	91	45.5
	Peripheral Neuropathy	109	54.5

Table 2 shows the majority of the 200 study subjects aged ≥ 55 years were 103 people (51.50%). 132 people (66%) were female. Subjects with married status were 190 people (95%). Low-educated subjects were 121 people (60.50%). Subjects who had income <Rp 1,800,000 were 113 people

(56.50%). Subjects with low health literacy were 110 people (55.00%). 112 respondents (56.00%) had low self-efficacy. As many as 116 (58.00%) patients were disobedient to the medication. Subjects with uncontrolled diet were 107 people (53.50%). Subjects with fasting blood sugar ≥ 110 mg / dL were

111 people (54.0%). The majority of low physical activity was 118 people (59.0%). Subjects with duration of illness  $\geq 5$  years were 123 people (61.50%) and 109 people (55.50%) experienced complications of peripheral neuropathy.

## 2. Bivariate Analysis

Table 3 shows the results of the chi-square test between the effects of age, income, health literacy, self-efficacy, medication adherence, diet, physical activity, duration of illness, and fasting blood sugar with peripheral neuropathy.

**Table 3. Bivariate Analysis**

Variable	Peripheral Neuropathy				Total		OR	p
	No		Yes		N	%		
	N	%	N	%				
<b>Age</b>								
<55 years old	68	70.1	29	29.9	97	100	8.15	<0.001
$\geq 55$ years old	23	23.3	80	77.7	103	100		
<b>Education</b>								
Low	28	23.1	93	76.9	121	100	0.07	<0.001
High	63	79.7	16	20.3	79	100		
<b>High</b>								
< Rp 1,800,000	21	18.6	92	81.4	113	100	0.05	<0.001
$\geq$ Rp 1,800,000	70	80.5	17	19.5	87	100		
<b>Health Literacy</b>								
Low	14	12.7	96	87.3	110	100	0.02	<0.001
High	77	85.6	13	14.4	90	100		
<b>Efficacy</b>								
Low	15	13.4	97	86.6	112	100	0.02	<0.001
High	76	86.4	12	13.6	88	100		
<b>Medication Adherence</b>								
Disobedient	20	17.2	96	82.8	116	100	0.03	<0.001
Obedient	71	84.5	13	15.5	84	100		
<b>Diet</b>								
Uncontrolled diet	14	13.1	93	86.9	107	100	0.03	<0.001
Controlled diet	77	82.8	16	17.2	93	100		
<b>Fasting blood sugar</b>								
< 110 mg/dL	78	87.6	11	12.4	89	100	53.45	<0.001
$\geq 110$ mg/dL	13	11.7	98	88.3	111	100		
<b>Physical activity</b>								
Not active	22	18.6	96	81.4	118	100	0.04	<0.001
Active	69	84.1	13	15.9	82	100		
<b>Duration of illness</b>								
< 5 years	57	74.0	20	26.0	77	100	7.46	<0.001
$\geq 5$ years	34	34.0	98	89.0	123	100		

Table 3 shows the results of the bivariate analysis of factors affecting peripheral neuropathy in type 2 DM patients including age  $\geq 55$  years (OR= 8.15;  $p < 0.001$ ). Education  $\geq$  senior high school (OR= 0.07;  $p < 0.001$ ). Income  $\geq$  Rp 1,800,000 (OR= 0.05;  $p < 0.001$ ). High health literacy (OR= 0.02;  $p < 0.001$ ). High self-effi-

cacy (OR= 0.02;  $p < 0.001$ ). Medication adherence (OR= 0.03;  $p < 0.001$ ). Controlled diet (OR= 0.03;  $p < 0.001$ ). Fasting blood sugar  $\geq 110$  mg/dL (OR = 53.45;  $p < 0.001$ ). Active physical activity (OR= 0.04;  $p < 0.001$ ). Duration of illness  $\geq 5$  years (OR= 7.46;  $p < 0.001$ ).

### 3. Multiple Logistic Regression

The results of multiple logistic regression analysis are shown in table 4. Table 4 shows the effect of age on peripheral neuropathy.

**Table 4. Multiple Logistic Regression**

Variables	b	95% CI		P
		Lower Limit	Upper Limit	
Age ≥ 55 years	3.61	1.51	5.70	0.001
Education ≥ senior high school	-2.41	-4.31	-0.51	0.013
Income ≥ Rp 1,800,000	-1.58	-3.12	-0.04	0.044
High health literacy	-1.52	-3.18	0.14	0.073
High self-efficacy	-1.67	-3.26	-0.07	0.040
High medication adherence	-2.34	-4.13	-0.56	0.010
Controlled diet	-1.89	-3.64	-0.14	0.034
High physical activity	-2.33	-4.17	-0.49	0.013
Duration of illness ≥ 5 years	2.78	0.51	5.04	0.016
Fasting blood sugar ≥ 110 mg/dL	1.64	-0.01	3.03	0.052
N observation= 200				
Likelihood= -26.35182				

There was an effect of education level on peripheral neuropathy. High education ≥ senior high school had logodds to decrease the risk of peripheral neuropathy by 2.41 units compared to low education <senior high school (b=-2.41; 95%CI= -4.31 to -0.51; p=0.013).

There was an effect of income on peripheral neuropathy. Income ≥1,800,000 had logodds to decrease the risk of peripheral neuropathy by 1.58 units compared to income <1,800,000 (b= -1.58; 95% CI= -3.12 to -0.04; p=0.044).

There was an effect of health literacy on peripheral neuropathy. High health literacy had logodds to decrease the risk of peripheral neuropathy by 1.52 units compared to low health literacy (b=-1.52; 95% CI= -3.18 to 0.14; p=0.073).

There was an effect of self-efficacy on peripheral neuropathy. High self-efficacy had logodds to decrease the risk of peripheral neuropathy by 1.67 units compared to low self-efficacy (b= -1.67; 95% CI= -3.26 to -0.07; p=0.040).

There was an effect of medication adherence on peripheral neuropathy. High

Age ≥55 years had logodds to increase the risk of peripheral neuropathy by 3.61 units compared to age <55 years (b = 3.61; CI 95%= 1.51 to 5.70; p=0.001).

medication adherence had logodds to decrease the risk of peripheral neuropathy by 2.34 units compared to low medication adherence (b=-2.34; 95% CI= -4.13 to -0.56; p=0.010).

There was an effect of diet on peripheral neuropathy. Controlled diet had logodds to decrease the risk of peripheral neuropathy by 1.89 units compared to uncontrolled diet (b=-1.89; 95% CI= -3.64 to -0.14; p=0.034).

There was an effect of physical activity on peripheral neuropathy. High physical activity had logodds to decrease the risk of peripheral neuropathy by 2.33 units compared to low physical activity (b= -2.33; 95% CI= -4.17 to -0.49; p=0.013).

There was an effect of duration of illness on peripheral neuropathy. Duration of illness ≥5 years had logodds to increase the risk of peripheral neuropathy by 2.78 units compared to duration of illness <5 years (b= 2.78; 95% CI= 0.51 to 5.04; p= 0.016).

There was an effect of fasting blood sugar on peripheral neuropathy. Fasting blood sugar ≥110 mg/dL had logodds to

increase the risk of peripheral neuropathy by 1.64 units compared to activity and fasting blood sugar <110 mg/dL (b= 1.64; 95% CI= -0.01 to 3.03; p= 0.052).

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## DISCUSSION

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### 1. The effect of duration of illness on peripheral neuropathy

This result of the study is in line with the result of a study conducted by Khawaja et al. (2018) that patients with type 2 diabetes mellitus with duration of diabetes  $\geq 5$  years tend to be at risk of having peripheral neuropathy compared to patients with type 2 diabetes mellitus <5 years. Jaiswal et al. (2017) state that the longer the duration of illness in patients with type 2 diabetes mellitus, the greater the risk of peripheral neuropathy. It occurs because patients with duration of illness <5 years can maintain blood glucose level better than patients with type 2 diabetes mellitus  $\geq 5$  years.

Prolonged hyperglycemia can reduce glycolysis in cells, increase oxidative stress and stimulate other pathways that cause nerve and endothelial dysfunction to blood vessels (Nisar et al., 2015)

Patients who have been diagnosed with type 2 diabetes mellitus for a long time have felt tired to do self-care action; in addition, the intention to do healthy behaviors has also decreased (Pranoto, 2017).

### 2. The effect of age on peripheral neuropathy

This result of the study is in line with the result of a study conducted by Karki et al. (2018) that the frequency of neuropathy at >55 years of age is higher than <40 years of age. Age over 60 years also tend to have peripheral neuropathy and diabetic foot ulcers (Kisozi et al., 2017).

According to Suwannaphant et al. (2017), the prevalence of diabetes mellitus tends to be experienced in people aged 51

years to 65 years. It occurs because the function of beta cells in the pancreas decrease with age. At the age of 40 years, people generally have a faster physiological decline (Babazadeh et al., 2017).

### 3. The effect of fasting blood sugar on peripheral neuropathy

The result of this study is in line with the result of a study conducted by Garoushi et al. (2019) that the higher the fasting blood sugar levels of diabetic patients, the greater the risk of peripheral neuropathy. It is 3.51 times greater than diabetic patients who have normal fasting blood sugar levels. However, normal fasting blood sugar can reduce the risk of peripheral neuropathy by 5 to 9 percent (Pop-Busui et al., 2017).

It occurs because persistent hyperglycemia leads to an increase in cytosolic and mitochondrial reactive oxygen species (ROS). In addition, it supports the deregulation of antioxidant defenses that are able to activate various metabolic pathways such as polyol, hexosamine, protein kinase C, Advanced Glycation End Products, glycosylation, and glycolysis. The active metabolic pathways support the occurrence of oxidative damage which ultimately leads to the occurrence of large-fiber damage specifically the nerves that are in the distal part (Sifuentes Franco et al., 2017)

### 4. The effect of medical adherence on peripheral neuropathy

This result of the study is in line with the result of a study conducted by Kassahun et al. (2016) that there is an association between medication adherence and blood sugar levels. High medication adherence will make blood sugar levels be controlled.

The use of controlled insulin and anti-glycemic drugs reduces the chance of peripheral neuropathy by 3.93 times compared to the use of uncontrolled drugs. The role of intensive glycemic control in prevention and controlled treatment makes the

chances of peripheral neuropathy lower (Wang et al., 2014). Controlling hyperglycemia through medication is the only way to reduce and prevent neuropathy from getting worse (Karki et al., 2018)

#### **5. The effect of diet on peripheral neuropathy**

This result of the study is in line with the result of a study conducted by Meng et al (2017) that low-carbohydrate diet interventions significantly reduce the concentration of blood sugar levels in the body. Dietary pattern by consuming more vegetables and fruits on the daily menu is one of the ways to improve glycemic control in patients with diabetes mellitus (Jiang et al., 2012).

According to Buscemi et al. (2013), the dietary principle for people with diabetes mellitus is to reduce and regulate carbohydrate consumption; therefore, it does not become a burden for the mechanism in the regulation of blood sugar levels. Eating management (diet) is a major component of the successful management of diabetes mellitus (Buscemi et al., 2013)

#### **6. The effect of physical activity on peripheral neuropathy**

According to van Dijk and van Loon (2015), physical activity carried out every day for 30 minutes is much more effective in controlling blood sugar levels than physical activity for 60 minutes/day which is done at certain times. Activities carried out consistently can provide benefits in maintaining good glycemic control of peripheral neuropathy (Yates et al., 2015).

According to Khawaja et al. (2018), physical activity will affect several mechanisms such as microvascular dilatation, attenuation of oxidative stress, and the release of neurotropic mediators which has role as modulators of inflammation and insulin sensitizers.

#### **7. The effect of health literacy on peripheral neuropathy**

Based on the result of a study conducted by Bailey et al. (2014), there is an association between health literacy and knowledge. Higher health literacy is associated with greater knowledge about diabetes. Health literacy is useful for understanding, assessing, and applying health information obtained.

Diabetes patients with low levels of health literacy are difficult to navigate a large number of recommendations regarding diet and physical activity behavior (Friis et al., 2016). The higher the health literacy of a patient with diabetes mellitus, the higher the health management behavior of a patient with diabetes mellitus (Chahardahcherik et al., 2018). The management of diabetes self-care includes blood glucose monitoring, physical activity, interpretation of laboratory data, modification of food intake, and medication administration (Huang et al., 2018).

#### **8. The effect of self-efficacy on peripheral neuropathy**

This result of the study is in line with the result of a study conducted by Tharek et al. (2018) that patients who have strong self-efficacy will increase self-care behavior by 0.53 times higher than patients with poor self-efficacy. The higher the one's self-efficacy, the better the self-care behavior; therefore, the risk of peripheral neuropathy is smaller (Masoompour et al., 2017).

Strong self-efficacy will make someone more obedient to the complications prevention behaviors. In addition, someone also believes in managing diabetes mellitus and believes that the management of diabetes mellitus carried out will produce a good effect on the disease (Prasetyowati et al., 2018).



### **9. The effect of education level on peripheral neuropathy**

This result of the study is supported by a study conducted by Devarajoo dan Chinna (2017), that there is an association between education level and self-efficacy. Someone with a high education level has better self-efficacy compared to someone with basic education towards the practice of self-care of diabetes mellitus.

The higher the education level, the better the ability to do glycemic control. It is because higher education increases health literacy and better knowledge about diabetes (Olesen et al., 2017). Diabetes mellitus patients with a high level of education are more likely to do physical activity regularly compared to patients with a low level of education (Steele et al., 2017)

Someone with a high level of education has a better awareness of diabetes mellitus complications such as peripheral neuropathy. Patients with higher education have better and correct diabetes management in using oral antidiabetic and insulin (Gedik and Kocoglu, 2018). In addition, someone will get better income which is closely related to the diet of diabetes mellitus (Budiarti et al., 2017)

### **10. The effect of income on peripheral neuropathy**

This result of the study is in line with the result of a study conducted by Babazadeh et al. (2017), that there is a significant association between family income and diabetes mellitus complications. The higher income will decrease the risk of complications such as peripheral neuropathy.

Low income is also closely related to the low utilization of health services. Besides, patients with peripheral neuropathy also need more health care costs than diabetes mellitus patients without complications (Juster-Switlyk and Smith, 2016).

According to Lee et al. (2011), individuals from low socio-economic status more often reduce discretion in fulfilling their food needs. This deficiency causes food insecurity in the family.

At low income levels, diabetes mellitus patients feel unable to meet their calorie needs. Therefore, they lose weight. As a result, they move to the cheaper foods. Combining higher-cost items, such as vegetables are more difficult because the food budget is increasingly insufficient. Maintaining a healthy diet within financial constraints need more time, motivation, planning, and knowledge (Seligman et al., 2012).

Peripheral neuropathy is directly affected by age, duration of illness, fasting blood sugar. Besides, peripheral neuropathy is indirectly affected by education, income, self-efficacy, diet, medication adherence, physical activity, and health literacy.

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#### **AUTHOR CONTRIBUTION**

Akhmad Azmiardi played a role in collecting the data, processing the data, and compiling the article. Didik Tamtomo helped in the discussion of peripheral neuropathy and revised the article. Bhisma Murti helped in developing the conceptual framework, analyzing the data, interpreting the results of the analysis, and revising the article.

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This study used independent fund.

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#### **CONFLICT OF INTEREST**

This is no conflict of interest.

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