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ANALYSIS DETERMINANTS OF TYPE 2 DIABETES MELLITUS: A CASE CONTROL STUDY

Analisis Determinan Kejadian Diabetes Mellitus Tipe 2: Studi Case Control

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ABSTRACT

Background: Type 2 Diabetes Mellitus (type 2 DM) is a chronic disease in adults due to the body's resistance to insulin. **Purpose:** This study aims to analyze the determinants of the incidence of type 2 DM. **Methods:** The study design was a case-control study. The case population in this study was patients with type 2 DM who had been diagnosed by doctors based on data available in the medical records of Bintang Bayu Health Center. In contrast, the control population was patients who did not suffer from type 2 DM. The study's sample size was 138 people, with a ratio of cases to controls of 1:2. The case group consisted of 46 people, and the control group comprised 92 people. The sampling technique used was nonprobability sampling, namely, consecutive sampling. Questionnaire distribution was the primary method of data collection. The frequency distribution of each variable was calculated before analyzing the data using Chi-square and logistic regression. **Results:** Diet ($p=0.001$; OR=4.7; 2.231–10.154), knowledge ($p=0.033$; OR=2.3; 1.129–4.785), physical activity $p = 0.010$; OR = 2.8; 1.342 – 6.032), hypertension ($p<0.001$; OR=4.9; 2.089–11.784) were significant to the incidence of type 2 DM. The most dominant variable was hypertension, $p<0.001$; OR=7.3 (2.581-20.680). **Conclusions:** Poor diet, poor knowledge, light physical activity, and hypertension were significant factors in the incidence of type 2 DM.

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ABSTRAK

Latar belakang: Penyakit Diabetes Melitus tipe 2 (DM tipe 2) merupakan salah satu penyakit kronis yang terjadi pada orang dewasa akibat resistensi tubuh terhadap insulin. **Tujuan:** Penelitian ini bertujuan untuk menganalisis determinan kejadian DM tipe 2. **Metode:** Desain studi berupa case control. Populasi kasus dalam studi ini adalah pasien DM tipe 2 yang telah didiagnosis oleh dokter berdasarkan data yang tersedia di medical record Puskesmas Bintang Bayu, sedangkan populasi kontrol adalah pasien yang tidak menderita DM tipe 2. Besar sampel penelitian sebanyak 138 orang dengan perbandingan antara kasus dan kontrol yaitu 1:2, kelompok kasus sebanyak 46 orang, dan kelompok kontrol sebanyak 92 orang. Teknik pengambilan sampel menggunakan nonprobability sampling yaitu consecutive sampling. Pengumpulan data dilakukan secara langsung dengan menyebarkan kuesioner. Analisis data penelitian dimulai dengan menghitung distribusi frekuensi masing-masing variabel dan dianalisis dengan menggunakan uji Chi square dan Regresi logistik. **Hasil:** Pola makan ($p < 0,001$; OR=4,7; 2,231–10,154), pengetahuan ($p = 0,033$; OR=2,3; 1,129–4,785), aktivitas fisik ($p = 0,010$; OR=2,8; 1,342–6,032), hipertensi ($p < 0,001$; OR=4,9; 2,089–11,784) signifikan terhadap kejadian DM tipe 2. Variabel paling dominan adalah hipertensi ($p < 0,001$; OR=7,3 (2,581–20,680)). **Simpulan:** Pola makan yang buruk, pengetahuan yang kurang baik, aktivitas fisik yang ringan dan penderita hipertensi signifikan terhadap kejadian DM tipe 2.

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INTRODUCTION

Type 2 Diabetes Mellitus (type 2 DM) is a major global public health problem that continues to grow, especially in developing countries (1). One of the biggest causes of death globally, diabetes also has devastating effects on people's health (2). Type 2 DM generally occurs in adults due to the body's resistance to insulin (3). Cardiovascular disease, peripheral vascular disease, diabetic neuropathy, cerebrovascular disease, retinopathy, nephropathy, and lower limb amputation are complications that can arise from type 2 DM (4,5).

Globally, the prevalence of type 2 DM, a non-communicable disease, is increasing rapidly (6). According to the International Diabetes Federation (IDF), 10.50% of adults aged 20 to 79 worldwide had diabetes in 2021, or about 536.6 million people. This number is expected to increase to 12.20% in 2045, or about 783.2 million people (7). Based on data from the World Health Organization, it was reported that in 1990, 200 million people were living with diabetes, and in 2022, this number increased to 830 million people (8). According to IDF Diabetes Atlas data, in Indonesia, the death rate

caused by diabetes in the 20-79 age group was 149.87 thousand people in 2011, increasing to 236.71 thousand people in 2021 (9). The data shows that the death rate from type 2 DM in Indonesia continues to increase, thus worsening the country's health and economic burden. According to the 2023 Indonesia Health Survey, the prevalence of diabetes among people aged ≥ 15 years or older reached 11.7%, up from 10.9% in 2018. Among the productive age group (18–59 years), the prevalence was 1.6% (based on medical diagnosis) and 10% (based on blood glucose tests). In North Sumatra, the prevalence of diabetes was recorded at 1.4% across all age groups and 1.9% among the population aged ≥ 15 years (10). In addition, based on data from the 2022 Serdang Bedagai Health Profile, the number of people with type 2 diabetes mellitus was recorded at 287, decreasing to 266 in 2023, but increasing again to 299 in 2024 (11).

The high morbidity and mortality rates of type 2 DM emphasize the importance of measuring the prevalence of diabetes and identifying those at high risk of developing type 2 DM with modifiable risk factors (12). Various factors, such as physical inactivity, obesity, male sex, unemployment, and

hypertension, can influence the increasing prevalence of type 2 DM (13). Other studies indicate that age >45 years, gender, hypertension, and duration of type 2 DM are risk factors for type 2 DM (14).

Although various previous studies have identified several risk factors contributing to the increasing prevalence of type 2 DM, until now, there have been no consistent research results on the dominant factor influencing the incidence of type 2 DM. Findings from previous studies vary across populations, but the interaction and impact of these risk factors remain poorly understood. Therefore, to manage type 2 DM well, it is important to understand the determinants related to the condition and apply appropriate treatment strategies. Overweight or obesity, dietary choices, physical activity levels, smoking, and alcohol use are the main risk factors for type 2 DM (15). In addition, based on the results of the initial survey of the study through interviews with eight patients with type 2 DM at the Bintang Bayu Health Center, Serdang Bedagai, it was found that 5 of the patients had insufficient knowledge regarding the risk factors for type 2 DM. This causes many of them to be unaware of the prevention efforts for type 2 DM, so they tend to adopt poor dietary habits, such as consuming foods and drinks high in sugar, as well as foods high in saturated fat, such as fatty meat, fast food, and sweet drinks. As a result, some of them suffer from hypertension. Thus, understanding the factors contributing to the prevalence of type 2 DM is very important, considering the high morbidity and mortality rates caused by this disease. Based on this phenomenon, it is important to conduct this study to analyze the determinants of the incidence of type 2 DM in the Bintang Bayu Health Center Work Area, Serdang Bedagai.

METHODS

This study is a quantitative study with a case-control design. This study was conducted at Bintang Bayu Health Center, Serdang Bedagai. The case population in this study was patients with type 2 DM who had been diagnosed by doctors based on data available in the Bintang Bayu Health Center medical records. In contrast, the control population was patients who did not suffer from type 2 DM. The study's sample size was 138 people, with a ratio of cases to controls of 1:2. The sample for the case group was 46 people, and the control group was 92 people. The sampling technique used was nonprobability sampling, namely, consecutive sampling. The inclusion criteria for the study

sample were (1) Patients aged 40-60 years, (2) there was complete data in the Bintang Bayu Health Center medical record, and (3) Subjects were willing to be respondents during the study. Then, the exclusion criteria were (1) subjects who could not be interviewed because they were sick, and (2) subjects who were not willing to be respondents during the study. In this study, the eligibility criteria did not restrict hypertension status to preserve exposure variability across case and control groups, thereby enhancing the ability to assess its potential causal relationship and epidemiological association with type 2 diabetes mellitus.

The independent variables of this study are dietary habits, knowledge, disease perception, physical activity, and hypertension. Rates of type 2 DM are the dependent variable. Research subjects received questionnaires to collect data. The research instrument has gone through the validity test stages, namely ($r \text{ count} > r \text{ table}$; $r \text{ table} = 0.361$) and reliability (Cronbach's alpha of 0.86; Alpha = 0.60). The characteristics of the research subjects in age consist of two categories, namely 1 = 51-60 years, 2 = 40-50 years, and the gender variable consists of two categories, namely 1 = male, 2 = female. The occupation variable includes 1 = unemployed, 2 = housewife, 3 = motorcycle taxi driver, 4 = private employee, 5 = government employee. Eating patterns consist of two categories, namely 1 = poor and 2 = good. Knowledge consists of two categories, namely 1 = poor and 2 = good. Disease perception consists of two categories, namely 1 = negative and 2 = positive. Physical activity consists of categories, namely 1 = light and 2 = moderate. Hypertension variables consist of two categories, namely 1 = suffering from hypertension and 2 = not suffering from hypertension. The incidence of type 2 DM consists of two categories, namely 1 = suffering from type 2 DM and 2 = not suffering from type 2 DM. As part of the informed consent process, all respondents were allowed to express their willingness to participate in this study before answering the questionnaire.

Participants' dietary patterns were measured using a validated semi-quantitative food frequency questionnaire (SQ-FFQ) adapted to local foods. Data from this questionnaire were then processed into daily energy and nutrient intake (carbohydrates, sugar, fat, fiber) to analyze their association with the incidence of type 2 diabetes mellitus and to identify dietary patterns that are at risk. Patient knowledge was measured using 10 questions with Yes/No answers, where correct answers were scored one and incorrect answers were scored 0, with a total score of 0-10.

Knowledge categories were divided into poor (score 0–5) and good (score 6–10). Patient perceptions were measured using a questionnaire consisting of 10 questions with a 1–5 Likert scale, where 1 = strongly disagree, 2 = disagree, 3 = somewhat disagree, 4 = agree, and 5 = strongly agree. The total score ranged from 10 to 50, with negative (10–30) and positive (31–50) categories. Hypertension status was assessed using medical record data from Bintang Bayu Health Center based on the most recent blood pressure measurement (within three months before the study). If ≥ 2 measurements were available, the mean of the two most recent readings was used. Hypertension was defined as systolic ≥ 140 mmHg and/or diastolic ≥ 90 mmHg, or use of antihypertensive medication; non-hypertension was defined as systolic < 140 mmHg, diastolic < 90 mmHg, and no use of antihypertensive medication.

Verifying the field data collected from questionnaire responses is the first step in processing research data. After that, a code is given to the completed questionnaire, and the data is transferred to the Microsoft Excel program. The data is then transferred to a computer program package for further examination to ensure no entry errors. In the final stage, the data is arranged as a frequency distribution table and a cross-table. Data analysis begins by calculating the frequency distribution of each variable and then continues with hypothesis testing using the Chi-Square test at $\alpha = 0.05$. In the final stage, a multivariate analysis using a binary logistic regression test was conducted to identify the dominant variables influencing the incidence of Type 2 DM. This research has received approval from the ethics committee of the Institut Kesehatan Medistra Lubuk Pakam with the number 006. D/ D/KEP-MLP/II/2024.

RESULTS

Table 1 shows that 60.90% of respondents aged 51–60 and 39.10% aged 40–50 suffered from type 2 DM. Based on gender, 69.60% of male respondents and 30.40% of female respondents suffered from type 2 DM. Regarding occupation, 32.60% of respondents who worked as private employees and 23.90% who worked as government employees suffered from type 2 DM. Age ($p = 0.009$; OR = 2.7; 95%CI 1.341–5.768) and gender ($p = 0.005$; OR = 3.1; 95%CI 1.464 – 6.589) significantly influenced the incidence of type 2 DM. However, the respondent's occupation did not considerably affect

the incidence of type 2 DM ($p = 0.385$; OR = 0.88; 95%CI 0.675 – 1.164).

Table 2 showed that 65.20% of respondents with a poor diet and 34.80% with a good diet suffered from type 2 DM. Based on knowledge, 56.50% of respondents with inadequate knowledge and 43.50% with good knowledge suffered from type 2 DM. Regarding disease perception, 52.20% of respondents with negative self-perception and 47.80% with positive self-perception suffered from type 2 DM. Based on physical activity, 69.60% of respondents with light physical activity and 30.40% with moderate physical activity suffered from type 2 DM. As many as 82.60% of respondents with hypertension and 17.40% without hypertension suffered from type 2 DM. Dietary habits, knowledge, physical activity, and hypertension significantly influenced the incidence of type 2 DM ($p < 0.05$). Table 3 shows that hypertension and dietary habits are the main factors affecting the occurrence of type 2 DM.

DISCUSSION

This finding is in line with previous studies that show that food consumption patterns significantly affect type 2 DM (16). A study in Saudi Arabia using a systematic review method reported that food consumption patterns play an essential role in determining the prevalence rate of diabetes in Saudi Arabia, where unbalanced eating habits are the primary causal factor in increasing cases of diabetes and the health complications that accompany it (17).

This finding aligns with previous studies, where 55.80% of respondents had a moderate level of knowledge about type 2 DM (18). Previous studies reported that most office workers in Mwanza City had poor knowledge of factors that increase the risk of developing type 2 DM, as many as 27.80% of whom had a good understanding, which was related to a family history of type 2 DM sufferers (3). Knowledge about type 2 DM can play an important role in reducing diabetes-related complications. In addition, lack of awareness leads to misunderstanding, which, coupled with inadequate knowledge, is a relevant barrier to proper diabetes management (19). To effectively control the disease, patients must know they must actively participate in therapy planning and monitoring, encouraging informed decision-making (19). This finding is in line with previous studies that reported that patient knowledge is significant to the occurrence of type 2 DM. As many as 58.60% said that DM can affect the eyes, and 56.40% said that

DM can affect the kidneys. Only 37.30% patients knew that DM can harm the heart (20). Another study also reported that a high level of knowledge does not always reflect good attitudes and practices regarding diabetes. Although understanding of diabetes is relatively good, related attitudes and actions often remain inadequate. Thus, specific strategies are needed to promote behavioral changes and the adoption of a healthy lifestyle to reduce the risk of diabetes (21).

In contrast to previous studies, this finding showed that the average disease perception score was 46.39 ± 9.45 (range 0-70) for type II diabetes. Disease perception was significantly associated with type 2 DM ($P < 0.001$, $r = 0.199$) (22). Positive perceptions of diabetes control can lead to more optimal health outcomes. A sense of personal power is closely related to patients' commitment and confidence in their ability to manage their disease and adhere to prescribed medications (23).

Table 1
Respondent Characteristics

Variables	Incident of DM Type 2				p-value	OR; 95%CI
	Cases		Control			
	f	%	f	%		
Age (Years old)						
51-60	28	60.90	33	35.90	0.009	2,7; 1.341-5.768
40-50	18	39.10	59	64.10		
Gender						
Male	32	69.60	39	42.40	0.005	3,1; 1.464-6.589
Female	14	30.40	53	57.60		
Jobs						
Unemployment	7	15.20	10	10.90	0.385	0,88; 0.675-1.164
Housewife	6	13.00	25	27.20		
Driver	7	15.20	11	12.00		
Private employees	15	32.60	32	34.80		
Government employees	11	23.90	14	15.20		

Source: Puskesmas Bintang Bayu, 2024

Table 2
Chi-Square Test

Chi-Square Test						
Variables	Incident of DM Type 2				p-value	OR; 95CI
	Cases		Control			
	f	%	f	%		
Diet						
Poor	30	65.20	26	28.30	<0.001	4.7; 2.231-10.154
Good	16	34.80	66	71.70		
Knowledge						
Poor	26	56.50	33	35.90	0.033	2.3; 1.129-4.785
Good	20	43.50	59	64.10		
Perception of disease						
Negative	24	52.20	36	39.10	0.202	1.7; 0.831-3.466
Positive	22	47.80	56	60.90		
Physical Activity						
Light	32	69.60	41	44.60	0.010	2.8; 1.342-6.023
Heavy	14	30.40	51	55.40		
Hypertension						
Hypertension	38	82.60	45	48.90	<0.001	4.9; 2.089-11.784
No hypertension	8	17.40	47	51.10		

Source: Puskesmas Bintang Bayu, 2024

Table 3

Binary Logistic Regression

Variables	Model 1	Model 2
	<i>p value</i> ; Exp(B) (95%CI)	<i>p value</i> ; Exp(B) (95%CI)
Diet	<0.001; 5.8 (2.384-14.049)	<0.001; 5.8 (2.404-14.164)
Knowledge	0.012; 3.3 (1.305-8.425)	0.006; 3.5 (1.435-8.696)
Self Perception	0.626; 1.3 (0.511-3.056)	-
Physical Activity	0.010; 3.2 (1.318-8.007)	0.009; 3.3 (1.343-8.138)
Hypertension	<0.001; 7.3 (2.581-20.680)	<0.001; 7.5 (2.661-21.171)

Source: Puskesmas Bintang Bayu, 2024

This finding aligns with previous studies indicating that patients with type 2 DM are advised to do physical activity/exercise as their first treatment. Exercise is an independent treatment that can prevent, delay, or reverse type 2 diabetes. However, moderate to vigorous exercise (e.g., 150 minutes/week) is often recommended with diet and/or behavior modification. Regular exercise, whether resistance training, aerobics, or both, promotes better short- and long-term glycemic control (24). In adults, a recent systematic review and meta-analysis of cohort studies found that moderate to vigorous walking, including brisk walking, may be associated with a reduced risk of type 2 diabetes, regardless of total physical activity or daily walking duration (25).

Previous studies have reported that hypertension and diabetes are two metabolic disorders that often occur together in the same individual. Both of these conditions increase the risk of cardiovascular disease, kidney dysfunction, and other complications. Diabetes and hypertension raise the risk of cardiovascular disease, a primary cause of death (26). The prevalence of hypertension, along with the level of awareness and control, is relatively high in individuals with type 2 DM. Because of the close relationship between hypertension and diabetes, it is important for diabetic patients to routinely monitor their blood pressure to prevent major complications that can arise from the condition (27). This study shows that the Bintang Bayu community's proximity to the sea influences their diet, including fried seafood, high-salt foods, and meat that can potentially increase blood pressure and the risk of insulin resistance.

Another systematic review and meta-analysis study reported that family history, high socioeconomic status, lack of exercise, urban residence, body mass index (BMI) > 25 kg/m², low vegetable consumption, and abdominal obesity were significant risk factors. These findings indicate that a positive family history is the most crucial risk factor for type 2 diabetes in Nigeria (28). Another study has reported that the two most

important risk factors for developing type 2 DM are high levels of triglycerides (TG) and hemoglobin (A1C) (29).

Research Limitations

One limitation of this study is the use of a consecutive sampling technique, which does not give all respondents an equal chance of being selected as the research sample. In addition, data collection through questionnaires is at risk of measurement bias, as it relies solely on respondents' memories, which may be inaccurate.

CONCLUSION

Dietary habits, knowledge, physical activity, and hypertension significantly affect the incidence of type 2 DM. Patients suffering from hypertension were found to be the most dominant risk factor for type 2 DM. Therefore, these findings highlight the importance of increasing awareness of the importance of a healthy diet, knowledge about diabetes, and management of hypertension as a preventive measure, as well as managing type 2 DM through the development and evaluation of intervention programs.

CONFLICT OF INTEREST

The authors declare that they have no competing interests.

AUTHOR CONTRIBUTIONS

In this study, NR and RAS were responsible for collecting data in the field, while RAS, VTH, RSS, DS, SH, and MS were involved in preparing the manuscript. In addition, VTH also played a role in data processing, analysis, and interpretation.

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