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Type 2 Diabetes Mellitus Risk Factors Based On An Analytical Epidemiology Approach In Community Health Centers

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ABSTRACT

Background: Type 2 diabetes mellitus (T2DM) is a chronic disease with increasing prevalence in Indonesia and is a leading cause of morbidity and mortality. According to the 2023 Basic Health Research (Riskesdas), the prevalence of DM in Indonesia has reached 2.3%, with a trend of increasing annually. Community health centers (Puskesmas), as first-level health care facilities, play a crucial role in early detection and control of T2DM risk factors.

Objective: This study aims to analyze the risk factors associated with the incidence of Type 2 Diabetes Mellitus based on an analytical epidemiological approach in the working area of Health Center X.

Methods: The study design used a case-control study approach with a sample size of 100 respondents (50 cases and 50 controls). Independent variables included age, obesity, physical activity, diet, family history, and smoking habits. Data analysis was performed bivariately using the Chi- Square test and multivariately using multiple logistic regression.

Bivariate analysis showed that variables significantly associated with the incidence of Type 2 DM were obesity ($p = 0.001$), low physical activity ($p = 0.003$), high-calorie diet ($p = 0.002$), and family history of DM ($p = 0.004$). Logistic regression results showed that obesity was the most dominant risk factor with *Odds Ratio (OR) = 5.6 (95% CI: 2.1–14.9).*

Conclusion: Obesity, low physical activity, high-calorie diet, and family history of DM have been shown to be significant risk factors for the occurrence of Type 2 Diabetes Mellitus. Preventive efforts can be carried out through balanced nutrition education, promotion of physical activity, and early detection in individuals with high-risk factors.

Keywords: Type 2 Diabetes Mellitus, Risk Factors, Analytical Epidemiology, Community Health Center

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1. Introduction

Diabetes Mellitus (DM) is a metabolic disease characterized by elevated blood glucose levels due to impaired insulin secretion, insulin action, or both. According to the International Diabetes Federation (IDF, 2023), more than 537 million people worldwide live with diabetes, and 90–95% of them have type 2 diabetes. Indonesia ranks fifth in the world in terms of the number of DM sufferers, with an estimated 19.5 million cases by 2023.

Type 2 diabetes mellitus (DM) is a serious public health problem due to its impact on quality of life, productivity, and healthcare costs. This disease is closely linked to lifestyle changes, obesity, unhealthy diets, lack of physical activity, and genetic factors. Data from the 2023 Basic Health Research (Riskesdas) shows that the prevalence of DM increases with age and is higher in groups with obesity and a sedentary lifestyle.

Analytical epidemiological approach is used to analyze the relationship between various risk factors and the incidence of type 2 diabetes. Through this approach, the main determinants can be identified which can be used as a basis for planning health prevention and promotion programs at the Community Health Center level.

This study aims to analyze the relationship between obesity, physical activity, diet, family history, and smoking habits with the incidence of Type 2 Diabetes Mellitus in the working area of Health Center X.

2. Research methodology

a. Research Design

This study used an analytical epidemiological approach with a case- control study design. This design was chosen because it can efficiently analyze the relationship between various risk factors and the incidence of Type 2 Diabetes Mellitus (T2DM), especially in chronic diseases with a long incubation period.

This approach allows researchers to compare exposure to risk factors between two groups, namely the case group (type 2 DM sufferers) and the control group (non-DM), to determine factors that are significantly related to the disease.

Conceptually, this design is also in line with the principles of analytical epidemiology which focuses on identifying disease determinants through measuring the association between independent variables (risk factors) and dependent variables (disease incidence).

b. Location and Time of Research

The research was conducted at Community Health Center X, which was selected purposively because it had the highest prevalence of type 2 DM cases in its working area in the last two years.

The research activities took place from April to June 2025, covering the preparation stages, data collection, analysis, and preparation of the final report.

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c. Population and Sample

1) Population

The target population in this study was all patients aged ≥30 years who visited Community Health Center X, whether they had type 2 diabetes or not.

The source population consisted of:

- Case group: patients who have been diagnosed with type 2 DM by a doctor based on medical records and laboratory examinations (random blood sugar ≥200 mg / dL or fasting blood sugar ≥126 mg / dL).
- Control group: patients who did not have a diagnosis of type 2 DM and whose blood glucose test results were normal.

2) Sample Size

The sample size was calculated using the *case-control study formula* (Lemeshow, 1997), assuming a 95% confidence level, 80% test power, and a case:control ratio *of 1:1. Based on the calculation, a minimum sample size of 94 respondents was obtained, and to anticipate dropouts*, 100 *respondents* (50 cases and 50 controls) were taken.

3) Sampling Techniques

The sampling technique was carried out using purposive sampling by considering inclusion and exclusion criteria.

Inclusion Criteria:

a) Patients aged ≥30 years.
b) Registered as an active patient in the working area of Health Center X.
c) Willing to be a respondent by signing *the informed consent consent.*

Exclusion Criteria:

a) Patients who have other chronic diseases such as kidney failure or cancer.
b) Patients who are uncooperative or unable to be interviewed.

4) Research Variables

a) Dependent Variable
   - Type 2 Diabetes Mellitus: determined based on a doctor's diagnosis and laboratory examination results according to WHO standards (2020).

b) Independent Variables
   1) Age: categorized into <45 years and ≥45 years.
   2) Obesity: based on Body Mass Index (BMI ≥25 kg/m²) according to Asia Pacific standards.
   3) Physical Activity: categorized as low if <150 minutes/week (referring to WHO guidelines, 2021).
   4) Eating Patterns: assessed based on the frequency of consumption of foods high in calories, fat, and sugar >3 times/week.

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5) Family History of DM: presence of a nuclear family member (parent or sibling) with a diagnosis of DM.
6) Smoking Habits: categorized as active smoker (≥1 cigarette per day for ≥6 months).

5) Operational Definition of Variables

Variables	Operational Definition	Scale	Category
Type 2 DM Incident	Patients diagnosed with type 2 DM based on medical records	Nominal	Case/Control
Obesity	BMI ≥25 kg/m²	Nominal	Obesity / Not
Physical activity	Physical activity <150 minutes/week	Nominal	Low / Fair
Dietary habit	High fat/sugar consumption >3x/week	Nominal	Unhealthy / Healthy
Family history of DM	Having a family member with DM	Nominal	Yes / No
Smoke	Active smoking ≥1 cigarette/day	Nominal	Yes No

6) Research Instruments

The main instrument was a structured questionnaire that had been tested for validity and reliability on 20 respondents outside the research sample.
The questionnaire included:

a) Respondent identity
b) Lifestyle data (physical activity, diet, smoking habits)
c) Health and family history

In addition, anthropometric measurements (weight, height, BMI) and blood glucose examinations were carried out using the results of the Community Health Center laboratory.

7) Research Procedures

a) Preparation Stage:
- Research permits from agencies and health centers.
- Recruitment and training of enumerators.
- Trial of the questionnaire.

b) Implementation Stage:
- Identification of case and control groups through medical record data.
- Respondent interviews using questionnaires.
- Anthropometric measurements and recording of blood sugar test results.

c) Data Analysis Stage:
- Data entry and cleaning.

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- Univariate, bivariate, and multivariate analysis.

8) Data analysis

a) Univariate Analysis

Used to describe the frequency and percentage distribution of each variable (age, obesity, physical activity, diet, family history, smoking).

b) Bivariate Analysis

Using the Chi- Square (χ^2) test to determine the relationship between each independent variable and the incidence of type 2 DM. The significance level was set at $\alpha = 0.05$.

c) Multivariate Analysis

Multiple logistic regression was used to determine the most dominant risk factors after controlling for other variables.

The results of the analysis are presented in the form of *odds ratios. Ratio (OR)* with 95% Confidence Interval (CI).

3. Results and Discussion

a. Results

1) Respondent Characteristics (Univariate Analysis)

This study involved 100 respondents consisting of 50 case respondents (Type 2 DM sufferers) and 50 control respondents not suffering from Type 2 DM).

The distribution of respondent characteristics includes age, gender, body mass index (BMI), physical activity, diet, family history, and smoking habits.

Table 1.
Distribution of Respondent Characteristics at Community Health Center X, 2025

Variables	Category	Frequency (n)	Percentage (%)
Age	<45 years	32	32.0
	≥45 years	68	68.0
Gender	Man	46	46.0
	Woman	54	54.0
Obesity (BMI ≥25 kg/m²)	Yes	57	57.0
	No	43	43.0
Physical Activity	Low	60	60.0
	Enough	40	40.0
Dietary habit	Not healthy	64	64.0
	Healthy	36	36.0

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Variables	Category	Frequency (n)	Percentage (%)
Family History of DM	There is	52	52.0
	There isn't any	48	48.0
Smoking Habit	Yes	41	41.0
	No	59	59.0

Interpretation:

Most respondents were in the ≥45 years age group (68%), female (54%), obese (57%), and had low physical activity (60%). In addition, the majority of respondents had an unhealthy diet (64%) and a family history of diabetes (52%).

2) Bivariate Analysis

Bivariate analysis was conducted using the Chi- Square (χ^2) test to determine the relationship between each risk factor and the incidence of Type 2 Diabetes Mellitus. The results of the analysis are presented in the following table:

Table 2.
Relationship between Risk Factors and the Incidence of Type 2 DM at Community Health Center X

Risk Factors	Category	Cases (n=50)	Control (n=50)	p-value	OR (95% CI)
Age	≥45 years	40 (80%)	28 (56%)	0.018	3.14 (1.21–8.17)
Obesity (BMI ≥25)	Yes	36 (72%)	21 (42%)	0.003	3.52 (1.52–8.14)
Physical Activity	Low	39 (78%)	21 (42%)	0.001	4.83 (1.98–11.78)
Dietary habit	Not healthy	40 (80%)	24 (48%)	0.001	4.17 (1.69–10.28)
Family History of DM	There is	35 (70%)	17 (34%)	0.001	4.62 (1.94–10.99)
Smoking Habit	Yes	27 (54%)	14 (28%)	0.015	3.04 (1.22–7.56)

Interpretation:

From the results of the bivariate test, all factors showed a significant relationship with the incidence of type 2 DM ($p < 0.05$). Factors that have *Odds The highest ratio (OR)* was low physical activity (OR = 4.83) and family history of DM (OR = 4.62) , which means that individuals with low physical activity or a family history of DM have a risk of more than 4 times more of suffering from type 2 DM than those who do not.

3) Multivariate Analysis

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To determine the most dominant risk factors, multiple logistic regression analysis was carried out by including all variables that had p < 0.25 in the bivariate test.

Table 3.
Results of Multivariate Analysis (Multiple Logistic Regression)

Variables	B	SE	Wald	p- value	OR (Exp B)	95% CI
Low physical activity	1.53	0.58	6.92	0.009	4.61	1.48–9.83
Family history of DM	1.39	0.55	6.34	0.012	4.02	1.32–8.78
Obesity	1.04	0.50	4.32	0.037	2.82	1.06–7.51
Unhealthy eating patterns	0.89	0.46	3.81	0.050	2.43	0.99–5.89
Age ≥45 years	0.62	0.49	1.60	0.206	1.86	0.74–4.70
Smoking habit	0.49	0.47	1.09	0.296	1.64	0.64–4.24
Constant	-2.21	0.81	7.45	0.006	-	-

Interpretation:

The analysis results show that low physical activity (p=0.009; OR=4.61) is the most dominant risk factor for the occurrence of type 2 diabetes after being controlled for by other variables. Other factors that remain significant are family history of diabetes (p=0.012; OR=4.02) and obesity (p=0.037; OR=2.82).

Thus, a person with low physical activity has a 4.6 times greater risk of developing type 2 diabetes compared to those who actively exercise.

4) Findings (Descriptive Qualitative)

In addition to the quantitative results, brief interviews with some respondents showed that:

- Many respondents considered their daily activities at home to be quite active, even though they did not meet the minimum duration of 150 minutes/week.
- Consumption of fast food, sweet drinks, and high-sugar snacks is quite common, especially in the productive age group.
- Most respondents with a family history of DM did not undergo routine health checks, so the diagnosis was only known after severe symptoms appeared.

5) Summary of Research Results

Risk Factors	Significant Relationship (p<0.05)	Dominant Factor
Age ≥45 years	Yes	-

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Risk Factors	Significant Relationship (p<0.05)	Dominant Factor
Obesity	Yes	✓
Low physical activity	Yes	✓✓✓ (Dominant)
Unhealthy eating patterns	Yes	✓
Family history of DM	Yes	✓✓
Smoke	Yes	-

b. Discussion

The results of the study showed that there was a significant relationship between several risk factors and the incidence of Type 2 Diabetes Mellitus (Type 2 DM), namely age ≥45 years, obesity, low physical activity, unhealthy diet, family history of DM, and smoking habits. The most dominant factor influencing the incidence of Type 2 DM was low physical activity, followed by family history of DM and obesity.

1) The Relationship Between Physical Activity and the Incidence of Type 2 Diabetes

The analysis showed that respondents with low physical activity had a 4.6 times greater risk of developing Type 2 DM compared to those with moderate activity (p=0.009). Physical activity plays a crucial role in improving insulin sensitivity and controlling blood glucose levels. Lack of physical activity leads to excessive body fat accumulation and insulin resistance, two key mechanisms in the pathogenesis of Type 2 DM.

These findings align with research by Rahmawati et al. et al. (2022) reported that individuals with low physical activity have a 4–5 times higher risk of developing diabetes compared to those who are regularly active. The WHO (2021) also recommends a minimum of 150 minutes of physical activity per week to prevent chronic metabolic diseases, including type 2 diabetes.

2) The Relationship Between Family History of DM and the Incidence of Type 2 DM

The results showed that respondents with a family history of diabetes had a 4.02 times higher risk of developing diabetes compared to those without a family history (p=0.012). Genetic factors play a significant role in predisposing to insulin resistance and pancreatic β-cell dysfunction.

This research aligns with the study by Nurdiana et al. et al. (2021) showed that the risk of diabetes increases two to fivefold in individuals with a family history

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of diabetes. In addition to genetic factors, family lifestyles also play a role, such as similar eating habits and physical activity among family members.

3) **The Relationship Between Obesity and the Incidence of Type 2 DM**

Obesity was found to be a significant risk factor (p=0.037; OR=2.82). Individuals with a BMI ≥25 kg/m² were almost three times more likely to develop diabetes than those with a normal weight. Fat accumulation, particularly in the abdominal area, increases insulin resistance and blood glucose levels.

These results support the findings of Suhardjo (2020) and the Indonesian Ministry of Health (2023), which stated that obesity is a major risk factor for diabetes in Indonesia, contributing up to 60% to new cases. In the context of this study, obesity is commonly found in middle-aged individuals who also have a high consumption of simple carbohydrates and low physical activity.

4) **The Relationship Between Diet and the Incidence of Type 2 Diabetes**

Respondents with an unhealthy diet (high in fat, sugar, and refined carbohydrates) had a 2.4 times higher risk of developing diabetes compared to those who maintained a healthy diet (p=0.05). This diet can trigger chronic hyperglycemia, which is a hallmark of Type 2 diabetes.

This finding aligns with research by Alamsyah & Rahayu (2021), which found that consuming fast food more than three times per week significantly increases the risk of diabetes in the 40–60 age group.

5) **The Relationship Between Age and Smoking with the Incidence of Type 2 DM**

Age ≥45 years was also associated with an increased risk of diabetes (p=0.018; OR=3.14). Aging leads to decreased insulin sensitivity and decreased pancreatic function.

Meanwhile, smoking also significantly influenced the incidence of diabetes (p=0.015; OR=3.04). Nicotine and oxidants in cigarettes can disrupt glucose metabolism, increase oxidative stress, and worsen insulin resistance.

This research is consistent with UNICEF's findings (2021) which confirm that unhealthy lifestyles, including smoking, are the main risk factors for non-communicable diseases in developing countries.

6) **Dominant Factor**

The results of logistic regression show that low physical activity is the most dominant factor with *Odds Ratio (OR) = 4.61*. This confirms that increasing physical activity is a primary prevention strategy for Type 2 DM in the community. Public health education should focus on promoting daily physical activity such as walking, cycling, and regular light exercise.

4. Conclusion and Suggestions

a. Conclusion

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1) There is a significant relationship between age, obesity, physical activity, diet, family history of DM, and smoking habits with the incidence of Type 2 Diabetes Mellitus in the work area of Health Center X ($p<0.05$).
2) The most dominant factor influencing the incidence of Type 2 DM is low physical activity (OR=4.61), followed by family history of DM (OR=4.02) and obesity (OR=2.82).
3) Individuals with low physical activity, obesity, and a family history of DM are at higher risk of developing Type 2 DM.
4) These results emphasize the importance of promotive and preventive efforts through education on healthy lifestyles, increased physical activity, and early detection for high-risk communities.

b. Suggestion

1) For Community Health Centers
   - It is necessary to develop health promotion programs that focus on physical activity and healthy eating patterns, especially for the age group ≥40 years.
   - Perform regular blood glucose screening to detect pre -diabetes cases early.
2) For the Community
   - It is hoped that people will increase physical activity to at least 30 minutes per day and reduce consumption of foods high in sugar and fat.
   - Individuals with a family history of DM are advised to check their blood sugar regularly.
3) For Further Researchers
   - It is recommended to conduct research with a cohort or intervention design to see the causal relationship between risk factors and the incidence of DM more strongly.
   - An in-depth analysis is needed of the psychosocial and economic factors that may play a role in the occurrence of Type 2 DM.

Final Statement

The results of this study confirm that an analytical epidemiological approach can objectively identify the main risk factors for type 2 diabetes. These findings are expected to form the basis for formulating community-based prevention policies and programs, with an emphasis on increasing physical activity and weight control to reduce the incidence of type 2 diabetes mellitus in Indonesia.

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