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The Relationship Between Physical Activity and Dietary Patterns with Blood Sugar Control in Patients with Type 2 Diabetes Mellitus in Karawang Regency in 2025

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ABSTRACT

Diabetes mellitus ranks as the third leading cause of death in Indonesia, accounting for 6.7% of all fatalities, with the country holding the seventh position globally in diabetes prevalence at 8.5%. In Asia, 16.2% of the population has *type 2 diabetes mellitus*, while Indonesia's prevalence reached 6.7% in 2020. The study's main objectives are to identify the most influential factors and examine the relationship between dietary patterns, physical activity, and blood sugar control. This observational analytic study with a cross-sectional design was conducted at three community health centers in Karawang Regency—Medangasem, Rengasdengklok, and Karawang—selected through random sampling and involving 111 patients with *type 2 diabetes mellitus*. Data were collected using validated questionnaires and analyzed using chi-square tests and multiple logistic regression. Results demonstrated significant associations between physical activity ($p < 0.001$), fat intake ($p = 0.004$), and carbohydrate intake ($p = 0.015$) with blood sugar control, while protein intake, vitamin C intake, and vitamin A intake showed no significant associations. Physical activity emerged as the most dominant factor influencing blood sugar control ($p < 0.001$, OR = 5.636, 95% CI: 2.230–14.245). These findings underscore the critical role of physical activity and dietary management in controlling blood glucose levels among patients with *type 2 diabetes*. It is recommended that individuals with *type 2 diabetes* pay closer attention to their dietary intake to align with nutritional guidelines, maintain controlled blood glucose levels, and engage in regular physical activity of at least 30 minutes daily.

KEYWORDS *Blood Sugar Levels, Physical Activity, Diet.*

INTRODUCTION

The Sustainable Development Goals (SDGs) are an agenda created with the aim of improving human welfare around the world (Keeling et al., 2019; Kumar et al., 2016; Lim et al., 2018). The SDGs were developed to meet global leadership demands to end poverty, social inequality, and climate change (Diouf, 2019; Sarangi, 2019). Ensuring healthy lives and promoting well-being for people of all ages is the third Sustainable Development Goal (SDG) for 2030. This third section includes 13 target indicators and 50 indicators, one of which pertains to reducing the incidence of illness and mortality related to both communicable and non-communicable diseases. The SDGs set a target to reduce premature deaths from non-communicable diseases (NCDs) by one-third by 2030. One of the four most important NCDs to reduce is diabetes mellitus (DM) (Musthakimah & Yuniartika, 2019).

Diabetes is a serious public health concern and one of the four major degenerative diseases that world leaders have identified as a priority (WHO Global Report, 2024). Diabetes

mellitus (DM) is a chronic disease in which the pancreas does not produce enough insulin or the body is unable to use insulin effectively. The number of adults with diabetes has more than tripled in the last 20 years, making diabetes mellitus one of the 21st century's fastest-growing health issues, according to the International Diabetes Federation (ADA American Diabetes Association, 2018). A pancreas that is unable to create enough insulin to fulfill the body's needs is a common characteristic of people with diabetes. Without insulin, the body's cells are unable to absorb glucose and convert it into energy. The number of people with diabetes increased from 108 million in 1980 to 422 million in 2014. The prevalence of diabetes is rising more rapidly in low- and middle-income countries than in high-income countries. Diabetes was directly responsible for 1.5 million deaths in 2019, with 48% of those deaths occurring before the age of 70 (Organization, 2018).

One of the 21st century's fastest-growing global health emergencies, diabetes affects roughly 537 million people worldwide in 2021; this number is expected to rise to 643 million by 2030 and 783 million by 2045. In addition to the high number of people with diabetes, there are also an estimated 541 million people with impaired glucose tolerance (IGT), also known as elevated blood glucose levels or in the prediabetes phase. Diabetes in this population also results in high mortality rates related to diabetes, with an estimated more than 6.7 million deaths among adults aged 20–79 years (International Diabetes Federation, 2020).

The Asian continent ranks quite high in terms of diabetes cases. According to the IDF (2021), the prevalence of diabetes mellitus (DM) reaches 16.2% or approximately 72.7 million people living with diabetes in the Middle East region. The country with the highest incidence of DM is China, with 140.9 million people living with DM in 2021, followed by India with 74.2 million people living with diabetes (Fatmawati, 2010).

Diabetes is one of the diseases caused by unhealthy lifestyle factors. This makes the Southeast Asian region, which is home to 10 countries, a particular concern for the world in terms of diabetes incidence. According to the IDF (2021), the prevalence of diabetes in the Southeast Asian region reaches 8.7% or 90.2 million people living with diabetes. The country with the highest incidence of diabetes in the Southeast Asian region is Indonesia, with 19.5 million people living with diabetes in 2021 (Fradina & Nugroho, 2020).

IDF data from 2020 also states that Indonesia is a country that needs attention in relation to diabetes cases. This must be anticipated because Indonesia ranks seventh out of ten countries with the highest number of diabetes patients. In 2020, there were 6.2% of Indonesians with diabetes, or around 10.8 million persons with the disease. By 2045, this number is expected to rise to 16.7 million patients. Based on the 2020 data, 1 in 25 Indonesians or 10% of the Indonesian population has diabetes (Frankilawati & Sudaryanto, 2014). Research on the connection between food and exercise in regulating blood sugar levels in individuals with type 2 diabetes at the Karawang District Health Center in 2025 is required based on the background information provided above (Ardhiyanto, 2019).

Despite extensive global research on diabetes management, significant knowledge gaps remain regarding the specific relationships between lifestyle factors and blood sugar control in Indonesian populations, particularly at the district level. While international studies have established the general importance of physical activity and diet in diabetes management, the specific dietary patterns, physical activity levels, and their interactions within Indonesian cultural and socioeconomic contexts remain underexplored.

Previous research has provided important foundations for understanding diabetes management. A study by Cicilia et al. (2018) examining 80 respondents at Bitung Regional General Hospital found a significant association between physical activity and type 2 diabetes mellitus occurrence (p=0.026), with 57.5% engaging in moderate physical activity and 42.5% in heavy physical activity. Similarly, Nurayati & Adriani (2017) demonstrated a strong correlation between physical activity and blood glucose levels among 62 respondents at Mulyorejo Community Health Center in Surabaya (p=0.000), with 62.9% engaging in low-intensity physical activity. Regarding dietary patterns, research by Suprapti (2017) and Widyasari et al. (2022) demonstrated relationships between carbohydrate consumption and blood sugar levels, though results across studies have shown inconsistencies.

However, these previous studies present several limitations that the current research aims to address. First, most existing studies have focused on single variables (either physical activity or single dietary components) rather than comprehensive assessments of multiple dietary nutrients simultaneously. Second, limited research has been conducted specifically in Karawang Regency, where local dietary patterns, agricultural practices, and socioeconomic conditions may differ from other Indonesian regions. Third, few studies have employed multivariate analysis to identify the most dominant factors among multiple lifestyle variables, which is crucial for developing targeted and efficient interventions.

This study addresses the identified research gaps through several novel approaches. First, it employs a comprehensive, multi-dimensional assessment of dietary patterns, examining not only macronutrients (carbohydrates, proteins, fats) but also micronutrients (vitamins A and C) in relation to blood sugar control. Second, it utilizes multiple logistic regression to simultaneously analyze multiple variables and identify the most dominant factors, providing evidence for prioritized interventions. Third, it focuses specifically on Karawang Regency, contributing localized evidence that can inform district-level health policies and community health center programs. Fourth, this research integrates findings with practical recommendations including the proposed "GERTAK AKPOL" (Active Physical Activity and Dietary Pattern Movement) innovation, bridging the gap between research evidence and implementable public health interventions.

Analyzing risk variables related to blood sugar control in patients with type 2 diabetes mellitus at the Karawang District Health Center is the goal of this study. The study's main goals are to determine the most important factors and examine the connection between food and physical activity and blood sugar regulation. This study also details the percentage of patients according to food habits, physical activity, and sociodemographic characteristics. Practically, the study results are expected to serve as a foundation for evaluating diabetes prevention services and contribute to local government efforts, particularly the Health Department, in blood sugar control programs (Cicilia et al., 2018). Theoretically, this study adds to knowledge in the field of public health, particularly regarding blood sugar control in patients with type 2 diabetes mellitus, and can serve as a reference for further research. For the author, this study provides direct experience, broadens knowledge, and fulfills one of the requirements for completing a master's degree in public health at the University of Indonesia Maju.

RESEARCH METHOD

Using a cross-sectional design, this observational analytical study looks at the link between independent variables (risk factors) and dependent variables (effects) without the use of treatment or intervention (Alfiyah, 2010). The study was conducted at three community health centers in Karawang Regency selected using simple random sampling, namely Medangasem Community Health Center, Rengasdengklok Community Health Center, and Karawang Community Health Center, taking into account representation of urban, rural, and transitional areas. The study period, from proposal development to examination, took place from April to June 2025. The study population includes all patients with type 2 diabetes mellitus receiving outpatient care at the three Puskesmas, while the sample consists of a portion of that population (Handayani et al., 2018). The selection of locations was conducted randomly from a total of 50 community health centers under the auspices of the Karawang District Health Office, resulting in the selection of the Karawang and Rengasdengklok community health centers (urban and transitional areas), as well as the Medangasem community health center (rural area).

Inclusion and Exclusion Criteria

Inclusion

1. Residing in Karawang Regency
2. Willing to be a research respondent
3. Registered in the Karawang Community Health Center Medical Records

Exclusion

1. Having a serious illness that makes it impossible to communicate
2. Not knowing the respondent's diabetes mellitus status

Sample Size

The sample size in this study was calculated using the Slovin formula (Sugiono, 2011) as follows:

$$n = \frac{N}{N.d^2 + 1}$$

Description

n: Minimum number of samples required

N = Total population (2,344 patients with diabetes mellitus from 3 community health centers)

d: Limit of error or absolute precision 10% (0.1)

So that :

$$n = \frac{2.344}{2.344\ x\ (0{,}1)^2 + 1}$$

$$n = \frac{2.344}{2.344 \text{ x } 0{,}01 + 1}$$

$$n = \frac{2.344}{24{,}44}$$

$$n = 96{,}90$$

$n = 111$ (rounding)

So, the minimum sample size obtained in this study was 111 samples. Therefore, in this study, sample size calculations were performed for each research location, because the sample was proportional to the heterogeneous population and divided into three parts, namely the Karawang Kota Community Health Center, the Rages Dengklok Community Health Center, and the Medangasem Community Health Center. The sample size for each health center was calculated using the following formula:

$$Puskesmas\ Sample\ = \frac{\text{Puskesmas Population x sample}}{\text{Total Populatin}}$$

Because in this study, the results of the formula calculations were rounded up to maximize the sample size, each community health center that will be included in the study will have an additional 5 samples. Therefore, the sample size for each community health center is as follows:

Puskesmas Karawang Kota $= \frac{398 \text{ x } 96}{2.344}$

$= \frac{38.208}{2.344}$

$= 21$

Puskesmas Rangasdengklok $= \frac{1.362 \text{ x } 96}{2.344}$

$= \frac{130.752}{2.344}$

$= 61$

Puskesmas Medangasem $= \frac{584 \text{ x } 96}{2.344}$

$= \frac{56.064}{2.344}$

$= 29$

This study used probability sampling with a simple random sampling approach, giving each member of the population an equal chance of being selected as a sample. Respondents were selected from three selected community health centers, using a list of diabetes mellitus patients that was then randomized using the Statistics and Sample Size Pro application. Data were collected through direct interviews using a questionnaire guide, covering diabetes mellitus status (with medical record verification), physical activity measured using the PAL, and dietary patterns (carbohydrate, protein, fat, vitamin A, and vitamin C intake). Data processing included editing to check completeness and relevance, coding according to the operational definitions of variables, data entry into a computer, data cleaning to remove incorrect or duplicate data, and analysis using statistical software. The analysis was conducted descriptively to describe the data based on person, place, and time variables, as well as multiple logistic regression analysis to test the simultaneous relationship between variables and formulate the research predictive index formula.

RESULTS AND DISCUSSION

The characteristics of respondents in this study are based on the distribution of proportions of independent variables, namely age, gender, education level, diet (fat, protein, carbohydrates, vitamin A, and vitamin C), physical activity, and dependent variables, namely blood sugar levels in patients with type 2 diabetes mellitus, as follows (Allorerung et al., 2016):

Table 1: Respondent Frequency Distribution by Research Variables

Variable	f	Percentage (%)
Blood Sugar Level		
Uncontrolled (≥126)	73	65,8
Controlled (<126)	38	34,2
Total	111	100,0
Age		
≥45 Year	98	88,3
<45 Year	13	11,7
Total	111	100,0
Gender		
Female	**83**	**74,8**
Male	**28**	**25,2**
Total	111	100,0
Latest Education		
Low Education	70	63,1
High Education	41	36,9
Total	111	100,0
Physical Activity		
Inactive	61	55,0
Active	50	45,0
Total	111	100,0
Fat Intake		
More	47	42,3
Normal	24	21,6
Deficit	40	36,1
Total	111	100,0
Protein Intake		
More	43	38,7
Normal	29	26,1
Deficit	39	35,2
Total	111	100,0
Variable	**f**	**Percentage (%)**
Carbohydrate Intake		
More	54	48,6
Normal	24	21,6
Deficit	33	29,8
Total	111	100,0
Vitamin A intake		
Sufficient	62	55,9
Insufficient	49	44,1
Total	111	100,0
Vitamin C intake		
Sufficient	46	41,4
Insufficient	65	58,6

Total	111	100,0

Based on Table 1 in this study, it shows that the proportion of respondents based on blood sugar levels in Karawang Regency in 2025 is mostly in the uncontrolled category, totaling 73 people (65.8%), while those with controlled blood sugar levels are only 38 people (34.2%). Furthermore, the proportion of respondents based on age in Karawang Regency in 2025 is predominantly in the ≥45 years category, totaling 98 people (88.3%), while those under 45 years old only account for 13 people (11.7%). Furthermore, the proportion of respondents based on gender in Karawang Regency in 2025 was predominantly female, with 83 people (74.8%), while only 28 people (25.2%) were male. Furthermore, the proportion of respondents based on their highest level of education in Karawang Regency in 2025 was predominantly in the low education category, with 70 people (63.1%), while only 41 people (36.9%) were in the high education category.

Based on Table 1 in this study, it also shows that the proportion of respondents based on physical activity in Karawang Regency in 2025 is mostly in the inactive category, with 61 people (55.0%), while only 50 people (45.0%) are in the active category. Furthermore, the proportion of respondents based on fat intake in Karawang Regency in 2025 is predominantly in the category of higher fat consumption, totaling 47 people (42.3%), followed by the deficit category with 40 people (36.1%), and only 24 people (21.6%) in the normal category for fat intake. Furthermore, the proportion of respondents based on protein intake in Karawang Regency in 2025 was predominantly in the category of excessive protein consumption, with 43 people (38.7%), followed by the deficient category with 39 people (35.2%), and only 29 people (26.1%) in the normal category for protein intake.

Based on Table 1 in this study, it also shows that the proportion of respondents based on carbohydrate intake in Karawang Regency in 2025 is mostly in the category of consuming more carbohydrates, namely 54 people (48.6%), followed by the deficit category, namely 33 people (29.8%), while only 24 respondents (21.6%) fall into the normal category for carbohydrate intake. Furthermore, the proportion of respondents based on vitamin A intake in Karawang Regency in 2025 is predominantly in the adequate category, with 62 people (55.9%), while those in the insufficient category account for only 49 people (44.1%). Furthermore, the proportion of respondents based on vitamin C intake in Karawang Regency in 2025 was predominantly in the insufficient category for vitamin C consumption, totaling 65 people (58.6%), while those in the adequate category for vitamin C intake were only 46 people (41.4%).

Table 2. Statistical Analysis of Age

Unit of Analysis	Value
Mean	57,10
Median	58,00
Std. Deviation	11,658
Minimum	25
Maximum	83

Upon further analysis, the mean age of respondents in this study was 57.10, with a median of 58.00 and a standard deviation of 11.658. The youngest respondent in this study was a type 2 diabetes patient aged 25, while the oldest respondent was 83 years old.

Bivariate Analysis

In this study, bivariate statistical tests were conducted to analyze the relationship between physical activity and diet with blood sugar control in patients with type 2 diabetes mellitus, as follows:

1. The Relationship Between Physical Activity and KGD Control

Table 3. Cross-tabulation between physical activity and KGD control

Physical Activity	KGD Diabetes Mellitus Patients				Total	*p value*	PR (95% CI)
	Controlled		Uncontrolled				
	f	%	f	%			
Active	26	52,0	24	48,0	50 (100%)	0,001	1,673
Less Active	12	19,7	49	80,3	61 (100%)		(1,222-2,291)

According to Table 3 of this study, the majority of respondents who engaged in less physical activity—49 individuals, or 80.3%—had blood sugar levels that were out of control, whereas the majority of respondents who engaged in physical activity—26 individuals, or 52.0%—had blood sugar levels that were under control. With a p-value of 0.014 (<0.05), the results of the chi-square test demonstrated a significant relationship between blood sugar control and physical activity in Karawang Regency patients with type 2 diabetes mellitus in 2025.

The findings of the bivariate analysis between blood sugar control and physical activity in individuals with type 2 diabetes mellitus showed a prevalence ratio (PR) of 1.673, which indicates that individuals with the disease who engage in less physical activity have a 1.673-fold higher risk of experiencing uncontrolled blood sugar levels than those who engage in physical activity. The 95% Confidence Interval (CI) of 1.222–2.291 indicates that the findings in the sample are statistically significant at the population level in Karawang District.

Next is to analyze the relationship between diet and blood sugar control in patients with type 2 diabetes mellitus. In this case, the diet analyzed consists of macro and micro nutrients, including fat intake, protein intake, carbohydrate intake, vitamin A intake, and vitamin C intake. Each nutrient will be analyzed as follows:

2. The Relationship Between Fat Intake and KGD Control

Table 4. Cross Tabulation Between Fat Intake and KGD Control

Fat Intake	KGD Diabetes Mellitus Patients				Total	*p value*	PR (95% CI)
	Controlled		Uncontrolled				
	f	%	f	%			
Deficit	7	17,5	33	82,5	40 (100%)	0,004	0,774
Normal	14	58,3	10	41,7	24 (100%)		(0,598-1,002)
More	17	36,2	30	63,8	47 (100%)		0,505
							(0,308-0,828)

Based on Table 4 in this study, it can be seen that most patients with diabetes who consume excessive amounts of fat have uncontrolled blood sugar levels, totaling 30 people (63.8%). while among diabetes patients who consumed fat within normal limits, the majority

had controlled blood sugar levels, totaling 14 individuals (58.3%), and among diabetes patients who were deficient in fat consumption, the majority had uncontrolled blood sugar levels, totaling 33 individuals (82.5%).

The findings of the chi-square test showed a significant correlation between blood sugar control and fat intake in Karawang Regency patients with type 2 diabetes mellitus in 2025, with a p-value of 0.006 (<0.05).

The results of the bivariate analysis between fat intake and blood sugar control in patients with type 2 diabetes mellitus calculated the prevalence ratio (PR) twice. This is because the fat intake variable has more than two categories, so the analysis goes through two stages. In the first stage, comparing the reference category (fat intake deficit) with the high fat intake category yields a PR value of 0.774, meaning that a fat intake deficit reduces the risk of uncontrolled blood sugar levels by 0.774 times compared to high fat intake. In the second stage, comparing the reference category (fat intake deficit) with the normal fat intake category, the PR value was 0.505, meaning that a fat intake deficit reduces the risk of uncontrolled blood sugar levels by 0.505 times compared to normal fat intake.

The 95% confidence interval (CI) in the first stage, which compared the classification of higher fat intake with the classification of fat intake deficiency, yielded a 95% CI of 0.598-1.002. This indicates that the condition in the sample is not significant at the population level in Karawang Regency. Meanwhile, the 95% Confidence Interval (CI) value in the second stage, which compares the classification of normal fat intake with the classification of deficient fat intake, yields a 95% CI value of 0.308–0.828. This indicates that the condition in the sample is significant at the population level in Karawang Regency.

3. The Relationship Between Protein Intake and KGD Control

Table 5. Cross-tabulation between protein intake and KGD control

Protein Intake	KGD Diabetes Mellitus Patients				Total	*p value*	PR (95% CI)
	Controlled		Uncontrolled				
	f	%	f	%			
Deficit	13	33,3	26	66,7	39 (100%)	0,989	1,029
Normal	10	34,5	19	65,5	29 (100%)		(0,739-1,431)
Excess	15	34,9	28	65,1	43 (100%)		1,079 (0,754-1,545)

Based on Table 5 in this study, it can be seen that most patients with diabetes who consume excessive amounts of protein have uncontrolled blood sugar levels, totaling 28 people (65.1%). while among diabetes patients who consumed protein within normal limits, the majority had uncontrolled blood sugar levels, totaling 19 individuals (65.5%), and among diabetes patients with insufficient protein intake, the majority had uncontrolled blood sugar levels, totaling 26 individuals (66.7%).

Protein intake and blood sugar control in type 2 diabetic patients in Karawang District in 2025 did not significantly correlate, according to the chi-square test, which produced a p-value of 0.989 (>0.05).

The results of the bivariate analysis between protein intake and blood sugar control in patients with type 2 diabetes mellitus calculated the prevalence ratio (PR) twice, because the protein intake variable had more than two categories. resulting in a two-stage analysis. In the first stage, comparing the reference category (protein intake deficit) with the excessive protein

intake category yielded a PR value of 1.029, meaning that patients with diabetes mellitus who consume excessive protein intake are at a 1.029 times higher risk of experiencing uncontrolled blood sugar levels compared to patients with diabetes who consume protein in deficit. However, the 95% Confidence Interval (CI) for this value indicates that the condition in the sample is not significant at the population level in Karawang District.

Furthermore, in the second stage, which compared the reference (protein-deficient intake) with the normal protein intake category, a PR value of 1.079 was obtained, meaning that diabetes mellitus patients who consume normal protein intake are at risk of experiencing uncontrolled blood sugar levels 1.079 times higher than diabetes patients who consume protein-deficient intake. However, the 95% Confidence Interval (CI) value for this figure indicates that the conditions in the sample are not significant at the population level in Karawang Regency.

4. The Relationship Between Carbohydrate Intake and GDM Control

Table 6. Cross-tabulation between carbohydrate intake and GDM control

Carbohydrate Intake	KGD Diabetes Mellitus Patients				Total	*p value*	PR (95% CI)
	Controlled		Uncontrolled				
	f	%	f	%			
Deficit	8	24,2	25	75,8	33 (100%)	0,017	0,929
Normal	14	58,3	10	41,7	24 (100%)		(0,717-1,204)
More	16	29,6	38	70,4	54 (100%)		0,550 (0,330-0,917)

Based on Table 6 in this study, it can be seen that most patients with diabetes who consume excessive amounts of carbohydrates have uncontrolled blood sugar levels, totaling 38 people (70.4%). while among diabetes patients who consume carbohydrates within normal limits, the majority have controlled blood sugar levels, totaling 14 individuals (58.3%), and among diabetes patients who are deficient in carbohydrate consumption, the majority have uncontrolled blood sugar levels, totaling 25 individuals (75.8%).

A strong correlation between blood sugar control and carbohydrate intake was found in Karawang District in 2025 among patients with type 2 diabetes mellitus, according to the chi-square test results, which showed a p-value of 0.017 (<0.05).

The bivariate analysis between carbohydrate intake and blood sugar control in patients with type 2 diabetes mellitus calculated the prevalence ratio (PR) twice, as the carbohydrate intake variable has more than two categories. so the analysis went through two stages: in the first stage, comparing the reference category (carbohydrate intake deficit) with the excessive carbohydrate intake category yielded a PR value of 0.929, meaning that a carbohydrate intake deficit reduces the risk of uncontrolled blood sugar levels by 0.929 times compared to excessive carbohydrate intake. Next, in the second stage, which compares the reference category (carbohydrate intake deficit) with the normal carbohydrate intake category, a PR value of 0.550 is obtained, meaning that a carbohydrate intake deficit reduces the risk of uncontrolled blood sugar levels by 0.550 times compared to normal carbohydrate intake.

The 95% Confidence Interval (CI) value in the first stage, which compares the classification of higher carbohydrate intake with the classification of carbohydrate-deficient intake, yields a 95% CI value of 0.717–1.204. This indicates that the condition in the sample is not significant at the population level in Karawang Regency. Meanwhile, the 95% Confidence Interval (CI) value in the second stage, which compares the classification of normal

carbohydrate intake with the classification of carbohydrate-deficient intake, yields a 95% CI value of 0.330–0.917. This indicates that the condition in the sample is significant at the population level in Karawang Regency.

5. The Relationship Between Vitamin A Intake and KGD Control

Table 7. Cross Tabulation Between Vitamin A Intake and KGD Control

Vitamin A intake	KGD Diabetes Mellitus Patients				Total	*p value*	PR (95% CI)
	Controlled		Uncontrolled				
	f	%	f	%			
Adequate	16	32,7	33	67,3	49 (100%)	0,912	0,958
Inadequate	22	35,5	40	64,5	62 (100%)		(0,732-1,253)

Based on Table 7 in this study, it can be seen that both respondents in the category of insufficient vitamin A intake and those in the category of adequate vitamin A intake mostly had uncontrolled blood sugar levels, with 40 people (64.5%) in the insufficient vitamin A intake group and 33 people (67.3%) in the adequate vitamin A intake group.

There was no significant correlation between vitamin A intake and blood sugar management in patients with type 2 diabetes mellitus in Karawang District in 2025, according to the chi-square test results, which showed a p-value of 0.912 (>0.05).

A prevalence ratio (PR) of 0.958 was obtained from the bivariate analysis of vitamin A intake and blood sugar control in patients with type 2 diabetes mellitus. This indicates that inadequate vitamin A intake lowers the risk of uncontrolled blood sugar levels by 0.958 times when compared to adequate vitamin A intake. The 95% Confidence Interval (CI) of 0.732–1.253 indicates that the conditions observed in the sample are statistically significant at the population level in Karawang District.

6. The Relationship Between Vitamin C Intake and KGD Control

Table 8. Cross Tabulation Between Vitamin C Intake and GDM Control

Vitamin C Intake	KGD Diabetes Mellitus Patients				Total	*p value*	PR (95% CI)
	Controlled		Uncontrolled				
	f	%	f	%			
Adequate	22	33,8	43	66,2	65 (100%)	1,000	0,986
Inadequate	16	34,8	30	65,2	46 (100%)		(0,750-1,296)

Based on Table 8 in this study, it can be seen that both respondents in the category of insufficient vitamin C intake and those in the category of adequate vitamin C intake mostly had uncontrolled blood sugar levels, with 30 people (65.2%) in the insufficient vitamin C intake group and 43 people (66.2%) in the adequate vitamin C intake group.

With a p-value of 1.000 (>0.05), the chi-square test findings for patients with type 2 diabetes mellitus in Karawang District in 2025 revealed no significant relationship between vitamin C intake and blood sugar control.

The bivariate analysis between vitamin C intake and blood sugar control in type 2 diabetes patients yielded a prevalence ratio (PR) of 0.986, indicating that insufficient vitamin C intake reduces the risk of uncontrolled blood sugar levels by 0.986 times compared to adequate vitamin C intake. The 95% Confidence Interval (CI) of 0.750–1.296 indicates that the condition in the sample is not statistically significant at the population level in Karawang Regency.

Summary of Bivariate Test Results

Multivariate Analysis

In this study, a multivariate test was conducted using multiple logistic regression, namely physical activity, fat intake, and carbohydrate intake variables.

Table 9. Stages of Multiple Logistic Regression Analysis Results for Blood Sugar Level Control

		B	S.E	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1a	recodeACTF(1)	1.487	.429	12.025	1	.001	4.424	1.909	10.251
	Constant	-.080	.283	.080	1	.777	.923		
Step 1b	recodeACTF(1)	1.729	.473	13.361	1	.000	5.636	2.230	14.246
	recodeKarbo			9.353	2	.009			
	recodeKarbo(1)	-1.866	.649	8.257	1	.004	.155	.043	.553
	recodeKarbo(2)	-.389	.540	.519	1	.471	.678	.235	1.952
	Constant	.442	.453	.953	1	.329	1.556		

Table 10. Final Results of Multiple Logistic Regression Analysis of Blood Sugar Control

No	Variable		B	Analysis Results		
				p-value	Exp (B)	95% CI *for* PR
1	Physical activity	Active (reference)	-	-	-	-
		Less active	1,729	<0,001	5,636	2,230-14,245
2	Carbohydrate Intake	Deficit (reference)	-	-	-	-
		Normal	-1,866	0,004	0,155	0,043-0,553
		More	-0,389	0,471	0,678	0,235-1,952
3	Fat Intake	Deficit (reference)	-	-	-	-
		Normal	-0,730	0,015	0,177	0,047-0,850
		More	-0,749	0,222	0,473	0,142-1,573
Constant			0,442	0,039	1,556	

The final findings of the logistic regression analysis carried out for this investigation are displayed in Table 10. This table shows that three significant variables—physical activity, carbohydrate intake, and fat intake—are examined concurrently with a p-value <0.05.

Analysis of the Most Dominant Variables

Based on the results of simultaneous statistical testing using multiple logistic regression, it can be concluded that there are three variables significantly associated with blood sugar control in patients with type 2 diabetes mellitus in Karawang Regency, namely physical activity, carbohydrate intake, and fat intake. Based on the analysis of significance values (p-values), B exponent values, and 95% confidence intervals (CI), it was found that physical activity is the strongest/most dominant variable compared to the others, with a p-value <0.001, a B exponent value of 5.636, and a 95% CI of 2.230–14.245.

Discussion

Based on the study's findings, data was gathered that revealed that 31 respondents (32.3%) had managed blood sugar levels, whereas 65 respondents (67.7%) had uncontrolled type 2 diabetes mellitus.

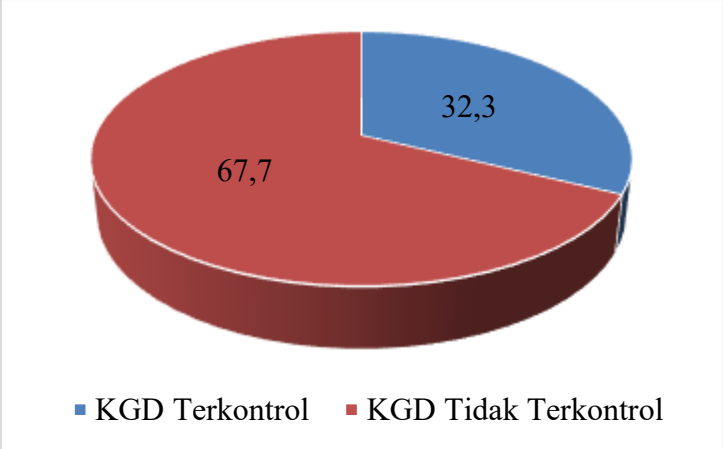

Figure 1. Pie chart showing the distribution of KGD proportions among type 2 diabetes mellitus patients in Karawang Regency in 2025.

The Relationship Between Physical Activity and Blood Sugar Control in Type 2 Diabetes Mellitus Patients in Karawang Regency in 2025

In Karawang Regency, type 2 diabetes mellitus patients' blood sugar management and physical activity were significantly correlated in 2025, according to the chi-square test results, which showed a p-value of 0.014 (<0.05). A prevalence ratio (PR) of 1.482 was obtained from the bivariate analysis of blood sugar control and physical activity in patients with type 2 diabetes mellitus. This means that patients with type 2 diabetes mellitus who engage in less physical activity have a 1.482-fold higher risk of experiencing uncontrolled blood sugar levels than those who engage in physical activity.

This study is in line with research conducted by (Cicilia et al., 2018), The study examined 80 respondents who visited the Internal Medicine Clinic at Bitung Regional General Hospital. 46 people (57.5%) of whom were categorized as engaging in moderate physical activity and 34 people (42.5%) were categorized as engaging in heavy physical activity. The results of the chi-square analysis yielded a p-value of 0.026, indicating a significant association between physical activity and the occurrence of type 2 diabetes mellitus.

The similar conclusion may be drawn from research by (Nurayati & Adriani, 2017), who discovered a strong correlation between physical activity and the incidence of type 2 diabetes mellitus as well as its impact on blood glucose levels. A sample of 62 respondents participated in this study, which was carried out at the Mulyorejo Community Health Center in Surabaya. Of these, 39 (62.9%) engaged in low-intensity physical activity, 13 (21.0%) in moderate physical activity, and 10 (16.1%) in high physical activity. The results of the chi-square test yielded a p-value of 0.000, indicating a significant association between physical activity and blood glucose levels.

According to (Nurayati & Adriani, 2017), wrote in his research that physical activity or exercise can increase the sensitivity of insulin receptors, allowing glucose in the blood to be converted into energy through the metabolic process. One of the many benefits of physical activity is that it can lower blood sugar levels in people with diabetes, prevent obesity, and play a role in preventing more serious health problems such as lipid disorders and hypertension.

Some physical activities, such as jogging, performed regularly for 30–40 minutes can trigger an increase in glucose uptake into cells by 7–20 times compared to not performing such activities. KGD in a person with diabetes can cause hypoglycemia or hyperglycemia. Hypoglycemia occurs when the body is unable to compensate for the high demand for glucose during excessive physical activity. Hyperglycemia, on the other hand, occurs when blood glucose levels exceed the body's capacity to store it, combined with low or insufficient physical activity (Sya'diyah et al., 2020).

However, there are research results that differ from this study, namely (Isnaini & Ratnasari, 2018), who stated in his research that there is no relationship between physical activity and blood sugar levels in type 2 diabetes mellitus at the Wangon I Community Health Center by studying 106 respondents, and obtained a chi-square statistical test result with a p-value of 0.224.

The Relationship Between Dietary Patterns and Blood Sugar Control in Type 2 Diabetes Mellitus Patients in Karawang Regency in 2025

This study classified the dietary patterns of patients with type 2 diabetes mellitus into two categories: macronutrients (carbohydrates, fats, and proteins) and micronutrients (vitamin A and vitamin C). The results of the chi-square test indicate a significant association between fat intake (p=0.004) and carbohydrate intake (p=0.027) with blood sugar control, while protein intake (p=0.918), vitamin A intake (p=0.443), and vitamin C intake (p=0.687) did not show a significant association. Adequate fat intake plays a role in metabolic and oxidative processes in the body, but excessive consumption can lead to insulin resistance and weight gain. Daily fat requirements vary by age and gender according to the 2019 Recommended Dietary Allowances (RDAs). These findings align with previous studies but differ from others that did not find a significant association.

Protein functions as a building and regulating substance, but research results show no significant relationship with blood sugar control. The majority of respondents consume protein above their needs, most of which comes from animal protein. These findings align with Ritonga's (2019) study, which identified a tendency toward excessive protein consumption in adulthood, but contradict Fauzi's (2018) study, which did not find such a correlation. Daily protein requirements also vary by age and gender, and excessive intake may result from habits of consuming high-protein foods.

Carbohydrates have been found to have a significant relationship with blood sugar control. Excessive carbohydrate intake can increase blood glucose levels, disrupt blood sugar balance, and trigger excessive insulin secretion. Daily carbohydrate requirements according to the 2019 Recommended Dietary Allowances (RDA) vary by age and gender. These findings align with the research by Suprapti (2017) and Widyasari et al. (2022), which demonstrated a relationship between carbohydrate consumption and blood sugar levels, although other studies have not found such a relationship.For micronutrients, vitamins A and C did not show a significant relationship with blood sugar control. Vitamin A plays a role in vision, immunity, growth, and protection of pancreatic β cells, while vitamin C plays a role in immunity and antioxidants. In this study, the primary sources of vitamin A were vegetables, fruits, eggs, and meat, while vitamin C was primarily obtained from fruits such as oranges, mangoes, apples, and vegetables like cauliflower. Other factors such as physical activity, stress, gender, and

obesity also influence blood sugar levels, so the intake of vitamins A and C alone is not sufficient to directly affect blood sugar control.

CONCLUSION

This study found that 65.8% of 111 patients with type 2 diabetes in Karawang Regency had uncontrolled blood sugar levels, with most being aged ≥45 years (88.3%), female (74.8%), low-educated (63.1%), physically inactive (55.0%), and exhibiting excessive fat (42.3%), protein (38.7%), and carbohydrate (48.6%) intake, alongside adequate vitamin A (55.9%) but insufficient vitamin C (58.6%) intake. Significant associations existed between physical activity ($p < 0.001$), fat intake ($p = 0.004$), and carbohydrate intake ($p = 0.015$) with blood sugar control, while protein, vitamin A, and vitamin C showed no links; physical activity was the dominant factor ($p < 0.001$, Exp(B) = 5.636, 95% CI: 2.230–14.245). Recommendations emphasize promoting healthy diets aligned with Recommended Dietary Allowances (RDA), regular blood sugar monitoring at community health centers, and daily 30-minute physical activity, including the innovative "GERTAK AKPOL" program—integrated into Puskesmas' Non-Communicable Diseases Management Program via bi-monthly education and light exercises to enhance quality of life. For future research, longitudinal studies could assess the long-term impact of "GERTAK AKPOL" on glycemic control and adherence, incorporating objective measures like accelerometers for physical activity and biomarkers for dietary intake to strengthen causal inferences.

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