

# The relationship between diet and the risk of diabetes mellitus in elementary school children grades 4-6 at Sdn Tasikmadu 1 Malang

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## ABSTRACT

The prevalence of Diabetes Mellitus (DM) among children in Indonesia has shown a significant increase in recent years. The rise in type 2 diabetes is influenced not only by genetic factors but also by unhealthy lifestyles, particularly poor dietary habits. This study aimed to examine the relationship between diet and the risk of diabetes mellitus among elementary school students in grades 4–6 at SDN Tasikmadu 1 Malang. This quantitative research used a cross-sectional design and was conducted in May 2025, involving a sample of 100 students. Data were analyzed using the Chi-square test. The results showed that among children with unhealthy diets, 27 students (46.6%) had a high risk of diabetes, while among those with moderate diets, 18 students (42.9%) had a low risk. Statistical tests showed a significant association between dietary patterns and diabetes risk ( $\chi^2 = 7.544$ ;  $p = 0.023$ ), with a linear-by-linear association ( $\chi^2 = 7.135$ ;  $p = 0.008$ ). These findings indicate that the less healthy a child's diet is, the higher their risk of developing early symptoms of diabetes. In conclusion, there is a significant relationship between dietary patterns and the risk of Diabetes Mellitus among elementary school children.

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## INTRODUCTION

Diabetes Mellitus (DM) is a chronic metabolic disorder characterized by elevated blood glucose levels resulting from defects in insulin secretion, insulin action, or both. In recent years, type 2 diabetes has increasingly affected not only adults but also children and adolescents. This emerging trend is strongly associated with unhealthy lifestyles and poor dietary habits. According to the 2023 Indonesian Health Survey, the prevalence of DM among children aged 5–14 years in East Java Province reached 138,465 cases. Furthermore, data from the Indonesian Pediatric Society (IDAI) revealed a seventyfold increase in childhood diabetes cases in 2023 compared to 2010, with two cases per 100,000 children. This alarming rise indicates that diabetes is no longer a disease confined

to adults but has become a growing public health concern threatening the well-being and development of children in Indonesia.

The increasing incidence of diabetes among children is influenced by both genetic and environmental factors, with dietary habits playing a pivotal role. Modernization and the widespread availability of high-calorie, low-nutrient foods have shifted children's eating behaviors toward convenience rather than nutrition. Today's children frequently consume fast food, sugary beverages such as soda and bubble tea, and processed snacks high in sugar, fat, and refined carbohydrates. These unhealthy eating patterns, coupled with sedentary lifestyles, contribute to obesity and insulin resistance major risk factors for type 2 diabetes (Pangestika & Rahmadiana (2022); Wahyuningsih & Astarini, (2018). Poor diet quality also disrupts metabolic homeostasis, increases oxidative stress, and impairs pancreatic  $\beta$ -cell function, leading to metabolic dysregulation and elevated blood glucose levels Yasin & Susilowati (2016). This relationship aligns with the Nutritional Metabolism and Energy Balance theories, which explain that excessive caloric intake and nutrient imbalance lead to metabolic stress and impaired insulin sensitivity in children.

A balanced and healthy diet plays a crucial role in maintaining stable blood glucose levels and preventing diabetes. According to the Ministry of Health of the Republic of Indonesia (2016), dietary balance should include proportional servings of carbohydrates, proteins, vegetables, and fruits, as outlined in the "My Plate" guideline a modern nutritional framework that replaces the outdated "Four Healthy, Five Perfect" concept. This approach emphasizes dietary diversity, portion control, and nutritional adequacy. However, many children, particularly in urban areas, fail to meet these nutritional standards. They often skip breakfast or consume instant and fried foods that are high in calories but low in vitamins, minerals, and fiber. Research by Utomo & Prasetyo (2021) found that irregular eating patterns can increase the risk of obesity, impair brain development, and disrupt metabolism, ultimately predisposing children to chronic diseases such as Diabetes Mellitus.

Globally, the World Health Organization (WHO) has recognized type 2 Diabetes Mellitus as one of the fastest-growing non-communicable diseases (NCDs) among children. This condition not only poses medical challenges but also affects growth, cognitive development, and social participation, leading to a decline in children's overall quality of life. In Indonesia, the situation is further aggravated by limited parental knowledge of healthy nutrition, lack of diabetes education, and easy access to high-sugar snacks commonly sold in school canteens (Susanti & Bistara (2018); Yusransyah & Sari (2022). Without early preventive interventions, the prevalence of childhood diabetes is projected to continue increasing, contributing to a greater burden of disease in adulthood.

Given these circumstances, it is essential to investigate the relationship between dietary habits and the risk of developing Diabetes Mellitus in children. Understanding how specific eating patterns influence glucose metabolism will support the development of effective early prevention strategies. Therefore, this study aims to examine the relationship between diet and the risk of Diabetes Mellitus among elementary school students in grades 4–6 at SDN Tasikmadu 1 Malang. The findings are expected to provide scientific evidence for school-based health promotion programs, enhance awareness of the importance of healthy eating behaviors, and guide parents, educators, and health professionals in preventing childhood diabetes through nutrition-centered interventions. This study also supports Indonesia's national agenda for preventing non-communicable diseases (RAN-PTM) and promotes the implementation of the Healthy Living Community Movement (GERMAS) by emphasizing balanced nutrition and early diabetes prevention in school-age children.

## RESEARCH METHOD

The study applied a quantitative non-experimental research design with a cross-sectional approach aimed at identifying the relationship between diet and the risk of Diabetes Mellitus among

elementary school children. Data were collected from primary sources using validated instruments, including the Food Frequency Questionnaire (FFQ) adapted from Tarawan et al., (2020) to assess students' dietary patterns and the Finnish Diabetes Risk Score (FINDRISC) developed by Lindström & Tuomilehto (2003) to estimate the risk of diabetes, complemented by Body Mass Index (BMI) measurements for anthropometric assessment. The FFQ categorized diet quality as high, moderate, or low, while FINDRISC classified diabetes risk into low, moderate, and high levels. The study population comprised 145 students aged 9–12 years (grades 4–6) at SDN Tasikmadu 1 Malang City, from which 100 respondents meeting the inclusion criteria were selected using a total sampling technique based on the Slovin formula. Inclusion criteria required students to be actively enrolled, able to complete the questionnaire, and willing to participate with parental consent, while exclusion criteria included absence due to illness or refusal to participate. Data collection was conducted on-site in May 2025 through supervised questionnaire sessions and direct anthropometric measurements using calibrated equipment. Responses were coded, tabulated, and analyzed using the Chi-Square ( $\chi^2$ ) test to determine the correlation between dietary patterns and diabetes risk, with a significance level of  $p \leq 0.05$ . The study ensured validity through the use of standardized instruments and maintained ethical compliance by obtaining informed consent, ensuring confidentiality, and allowing voluntary participation.

## RESULTS AND DISCUSSIONS

### Respondent Characteristics Data

**Table 1.** Characteristics data of children grades 4-6 at SDN Tasikmadu 1 Malang

	Characteris	Number of respondents	Presentase (%)
Age	10 Year	31	31 %
	11 Year	28	28 %
	12 Year	33	33 %
	13 Year	8	8 %
Gender	Male	47	47 %
	Female	53	53 %
IMT	<23,8 (Normal)	72	72 %
	23.8-26 (Fat)	11	11 %
	>26 (Obesity)	17	17 %

Based on Table 4.1 shows that the frequency of child characteristics based on gender with the most category being girls as many as 53 children (53%). This can be interpreted that the distribution of the number of girls at SDN Tasikmadu 1 Malang is indeed more than boys. The age of the largest respondents was 12 years old as many as 33 children (33%) from the 10–13 year range spread across classes A and B. This shows that most respondents were in the final period of Elementary School, which is an important period in the formation of good eating habits and lifestyles. The majority of BMI was in the normal category as many as 72 children (72%) and others were in the overweight category as many as 11 children (11%) and obesity as many as 17 children (17%). This finding shows that around 28% of children are overweight (fat and obese) which is an important factor in health problems including type 2 Diabetes Mellitus. Although the majority of children are still in the normal BMI range, the proportion of children with excess weight is quite significant so that it requires further attention, especially in relation to lifestyle, one of which is the eating patterns in children. The categorization of BMI in this study refers to the Indonesia (2020), which classifies nutritional status as normal (14.6–23.8), fat or overweight (23.8–26.0), and obesity (>26.0). This theoretical reference supports the interpretation that maintaining a balanced diet and adequate physical activity is essential in preventing excess body weight and reducing the risk of non-communicable diseases such as type 2 Diabetes Mellitus from an early age.

## Eating Patterns in Elementary School Children

**Table 2.** Data on the eating patterns of children grades 4-6 at SDN Tasikmadu 1 Malang

Characteristics	Frequency	Percentage (%)
Diabetes Trigger Diet (FFQ)		
High	58	58 %
Currently	42	42 %
Characteristics	Frequency	Percentage (%)
Breakfast		
Always (6-7x/week)	45	45 %
The Feeling of Pleasure While Eating		
Frequently (5-6x/week)	29	29 %
Snacking Habits		
Always (6-7x/week)	57	57 %
High Sugar Consumption		
Always (6-7x/week)	53	53 %
High Salt Consumption		
Always (6-7x/week)	45	45 %
High Fat Consumption		
Sometimes (3-4x/week)	54	54 %
Fast Food Consumption		
Sometimes (3-4x/week)	51	51 %
Eating Frequency in 1 Day		
2x a day	31	31 %
Finished 1 portion		
Always (6-7x/week)	51	51 %
Consumption of Vegetables and Fruits		
Sometimes (3-4x/week)	40	40 %

Based on Table 4.2 shows that among elementary school students in grades 4–6 at SDN Tasikmadu 1 Malang, the majority of respondents had high eating pattern scores as many as 58 children (58%), while 42 children (42%) were in the moderate category. This distribution indicates that most children have eating habits categorized as high-risk, characterized by frequent consumption of foods high in sugar, salt, and fat. Regarding eating behavior, most children reported having breakfast regularly (6–7 times per week), which reflects a positive habit; however, snacking frequency was also very high, with 57% of children stating that they snack almost every day. This suggests that although students begin their day with breakfast, their total dietary intake tends to be dominated by energy-dense but nutrient-poor foods such as instant noodles, fried snacks, and sweetened beverages.

In terms of food composition, 53% of children reported frequent consumption of high-sugar foods such as cakes, sweet drinks, and candies, while 45% consumed high-salt foods like chips and processed snacks. Meanwhile, 54% of respondents reported “sometimes” eating high-fat foods (3–4 times per week), and 51% consumed fast food such as fried chicken, burgers, or pizza at a similar frequency. This data reveals that students’ daily food choices are strongly influenced by convenience foods and taste preferences rather than nutritional value, contributing to excessive calorie intake. Furthermore, the majority of children ate only two main meals per day (31%), which indicates irregular meal frequency that may affect blood sugar stability and insulin function. Only 40% of children consumed vegetables and fruits regularly, showing a lack of dietary fiber, vitamins, and minerals that are crucial for metabolic balance and healthy growth.

These findings suggest that although some students demonstrate positive habits such as eating breakfast, their overall dietary quality remains poor due to high intake of sugar, salt, and fat combined with low fruit and vegetable consumption. This pattern aligns with Wa Ode Sri Asnaniar et al. (2024), who stated that eating patterns represent behaviors related to food choice and frequency that directly affect nutritional balance, and with Uwa & Milwati (2019), who emphasized that school-age children’s diets are largely shaped by lifestyle, environment, and

parental influence. According to the Ministry of Health of the Republic of Indonesia (2016), a balanced diet should consist of appropriate portions of carbohydrates, proteins, vegetables, and fruits as recommended in the *Isi Piringku* guideline. However, the results of this study indicate that these guidelines are not yet optimally applied among the students of SDN Tasikmadu 1 Malang.

Unbalanced eating patterns, as shown in this study, contribute to increased caloric intake without adequate nutritional diversity, which can lead to overweight and metabolic risks including early signs of type 2 Diabetes Mellitus. These findings are consistent with Utomo & Prasetyo (2021), who noted that irregular eating habits and excessive consumption of processed foods can disrupt metabolic processes and increase obesity prevalence among children. Therefore, promoting healthy school meal programs, reducing access to unhealthy snacks, and increasing parental supervision of children's eating habits are essential steps to improve dietary quality and prevent long-term metabolic health problems.

### Risk of Diabetes Mellitus in Elementary School Children

**Table 3.** Data on the risk of diabetes mellitus in children in grades 4-6 at SDN Tasikmadu 1 Malang

Characteristics	Frequency	Percentage (%)
Diabetes Mellitus Risk (FINDRISC)		
Low Risk	29	29 %
Moderate Risk	33	33 %
High Risk	38	38 %

Based on Table 4.3 shows that among elementary school students in grades 4-6 at SDN Tasikmadu 1 Malang, the majority were categorized as having a high risk of Diabetes Mellitus as many as 38 children (38%), followed by those in the moderate-risk category as many as 33 children (33%), and a low-risk category as many as 29 children (29%). This distribution indicates that more than one-third of the students already exhibit a high risk of developing Diabetes Mellitus, while only a small portion fall into the low-risk category. The high proportion of children with elevated risk suggests the existence of unhealthy lifestyle habits, including frequent consumption of sweet and fatty foods, irregular meal schedules, and limited physical activity intensity.

The presence of 38% of children classified as high risk reflects an early warning condition that may lead to metabolic imbalances, particularly reduced insulin sensitivity and impaired glucose tolerance. This condition is likely influenced by the students' eating behavior, which tends to include excessive intake of sugary snacks and low fruit and vegetable consumption, along with inadequate physical activity both at school and home. Furthermore, the previous findings showing that 28% of respondents were overweight or obese support the strong correlation between excess body weight and increased diabetes susceptibility among children.

From a theoretical perspective, these findings are consistent with Purwandari (2020), who explained that moderate to high diabetes risk in children is largely caused by sedentary lifestyle patterns and unbalanced nutrition, which lead to decreased insulin sensitivity. Likewise, Putra, (2015) and Hermayetty & Supriadi (2021) found that children who spend more than three hours per day engaged in screen-based activities without adequate physical movement are nearly twice as likely to experience elevated fasting glucose levels. According to the World Health Organization WHO (2022), children aged 5-17 years should engage in at least 60 minutes of moderate-to-vigorous physical activity daily to maintain normal metabolic function. Failure to achieve this activity level, coupled with poor dietary habits, significantly increases the risk of obesity-related diabetes. In line with this, Anderson et al. (2021) and Kirk et al. (2023) emphasized that low physical activity reduces GLUT-4 protein expression in muscle cells, decreasing glucose uptake and increasing the likelihood of hyperglycemia.

In conclusion, the findings of this study indicate that the majority of students at SDN Tasikmadu 1 Malang fall into the moderate-to-high risk categories for Diabetes Mellitus, suggesting that preventive interventions are urgently needed. Schools and parents should work collaboratively to promote balanced diets, enhance opportunities for active play and sports, and conduct early medical screening to identify and manage potential metabolic disorders. Early lifestyle intervention is essential to prevent the development of Type 2 Diabetes Mellitus and ensure healthy growth among school-aged children.

### The Relationship between Dietary Patterns and the Risk of Diabetes Mellitus in Elementary School Children

**Table 4.** Relationship between dietary patterns and the risk of diabetes mellitus in elementary school children in grades 4-6 at SDN Tasikmadu 1 Malang

Dietary habit	Low	Currently	High	Total	P Value
High	11 (19.0%)	20 (34.5%)	27 (46.6%)	58	0.023
Currently	18 (42.9%)	13 (31.0%)	11 (26.2%)	42	

The study found that among elementary school students aged 10–13 years at SDN Tasikmadu 1 Malang, the majority (58%) had high-risk dietary patterns, while 42% were categorized as having moderate eating patterns. Based on the analysis of diabetes risk categories, 38% of students were classified as having high risk, 33% as moderate risk, and 29% as low risk. The Chi-Square test yielded a p-value of 0.023 ( $p < 0.05$ ), indicating that there was a statistically significant relationship between dietary patterns and the risk of Diabetes Mellitus among the respondents. This finding suggests that students with unhealthy eating behaviors such as frequent consumption of high-sugar, high-fat, and high-salt foods tend to have a higher risk of developing early metabolic imbalances associated with diabetes. Although some children demonstrated moderate dietary habits, the dominance of high-risk patterns indicates that their food choices are largely energy-dense and nutrient-poor. Irregular meal frequency, high snack consumption, and low intake of fruits and vegetables further contribute to increased susceptibility to insulin resistance and glucose intolerance among the students.

From a theoretical perspective, this finding aligns with previous studies showing that poor dietary quality and frequent consumption of processed foods are directly correlated with increased diabetes risk in children. (arihoran & Silaban (2022) found that children with low dietary diversity were more likely to experience glucose dysregulation, while Handayani & Suryani (2024) reported that 53.3% of individuals consuming unhealthy foods were diagnosed with diabetes. Similarly, Dewita (2021) and Irayani (2024) stated that excessive intake of foods high in sugar, salt, and fat can lead to early onset of insulin resistance and obesity in childhood. According to the World Health Organization WHO (2022), balanced diets rich in vegetables, fruits, and whole grains are essential to maintain insulin sensitivity and prevent type 2 diabetes. However, the findings from SDN Tasikmadu 1 Malang indicate that most students' eating patterns are dominated by high-calorie and low-nutrient foods, reflecting a lack of adherence to these nutritional recommendations. This pattern limits the body's ability to regulate glucose effectively and increases the likelihood of metabolic disorders. Furthermore, Yasin & Susilowati (2016) and Nugroho (2015) explained that high-calorie, low-fiber diets contribute to oxidative stress,  $\beta$ -cell dysfunction, and chronic inflammation mechanisms that underlie type 2 Diabetes Mellitus. These theoretical insights support the current results, suggesting that while dietary behavior plays a crucial role in preventing diabetes, the prevalence of high-risk eating patterns among students underscores the need for nutrition education, parental supervision, and structured school programs promoting healthy dietary practices to effectively reduce diabetes risk in elementary school children.

## CONCLUSION

This quantitative cross-sectional study revealed that the relationship between dietary patterns and the risk of type 2 Diabetes Mellitus (DM) among elementary school students is influenced by a combination of nutritional, behavioral, and environmental factors rather than eating frequency alone. The findings show that although most children consume meals regularly, their diets are predominantly composed of foods high in sugar, salt, and fat, with insufficient intake of fruits and vegetables. This pattern reflects the pervasive influence of modern food consumption habits, where the easy availability of processed snacks, fast food, and sweetened beverages increases early metabolic vulnerability. The results reinforce theoretical perspectives proposed by WHO, Tarihoran & Silaban, and Handayani et al., emphasizing that the quality, balance, and nutritional composition of daily food intake are more critical for improving insulin sensitivity and glucose regulation than the mere number of meals consumed.

From a social and cultural standpoint, this study highlights the importance of integrated, school-based nutrition promotion programs that foster balanced eating habits, regulate the sale of unhealthy snacks in school environments, and involve parents as active partners in shaping children's dietary behaviors. Practically, the findings provide valuable input for the development of participatory and sustainable nutrition education models at the elementary school level. Such programs should incorporate engaging activities, peer learning, and collaboration between teachers, health professionals, and parents to strengthen children's understanding and practice of healthy eating behaviors.

In terms of future research directions, these findings open opportunities for nutritional intervention trials to evaluate the effectiveness of balanced diet education, as well as longitudinal studies to monitor changes in children's metabolic profiles over time using biochemical indicators such as fasting blood glucose, HbA1c, and lipid levels. Expanding research across multiple schools and diverse socioeconomic settings will enhance generalizability and contribute to the development of evidence-based, culturally relevant diabetes prevention frameworks for Indonesian children. Despite its contributions, this study is limited by its single-site design and reliance on self-reported food frequency data, underscoring the need for more comprehensive and multidisciplinary approaches in future investigations.

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