

The Relationship between Lifestyle (Dietary Patterns, Physical Activity, and Smoking) and the Risk of Type 2 Diabetes Mellitus among Adolescents at SMA Negeri 1 Jambi City, Indonesia

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ABSTRACT

Type 2 Diabetes Mellitus (DM) is no longer confined to adults but has shifted to younger age groups, including adolescents. Lifestyle changes such as unhealthy dietary patterns, low physical activity, and smoking habits are suspected to increase the risk of type 2 DM among school-age youth. This study aimed to analyze the relationship between lifestyle factors including dietary patterns, physical activity, and smoking habits and the risk of type 2 DM among adolescents at SMA Negeri 1 Kota Jambi. This was an observational analytic study with a cross-sectional design. A total of 92 respondents were selected using purposive sampling. Independent variables included dietary patterns, physical activity, and smoking habits, while the dependent variable was the risk of type 2 DM, determined by family history, BMI status, and hypertension history. Data were collected using a lifestyle questionnaire and anthropometric measurements, then analyzed using the Chi-square test with a significance level of $p < 0.05$. Most respondents had poor dietary patterns (72.8%), insufficient physical activity (53.3%), and did not smoke (94.6%). Bivariate analysis showed that dietary patterns were significantly associated with the risk of type 2 DM

($p=0.000$), as was physical activity ($p=0.030$). In contrast, smoking habits were not associated with the risk of type 2 DM ($p=0.615$). Dietary patterns and physical activity were significantly related to the risk of type 2 DM among adolescents, while smoking habits showed no significant relationship

Keywords: Type 2 Diabetes Mellitus, Adolescents, Dietary Patterns, Physical Activity, Smoking Habits

INTRODUCTION

The phenomenon of non-communicable diseases (NCDs) is increasing worldwide, including in Indonesia (Mukhtar et al., 2020; Page et al., 2021). One NCD of major concern is Type 2 Diabetes Mellitus (DM), which was previously more common in adults but has now shifted to younger age groups, including adolescents. This shift is closely related to changes in modern adolescent lifestyles, such as increased consumption of fast-food high in sugar and fat, low physical activity due to a sedentary lifestyle, and smoking habits among some adolescents (Majeed & Hassan, 2011). Adolescents, who should be in their optimal growth and developmental stage, are instead facing serious health threats if healthy lifestyles are not adopted early. This

phenomenon indicates that the risk of type 2 DM is no longer merely a future threat but is already a reality among early productive age groups (Fletcher et al., 2018).

Although public awareness of the dangers of DM is generally increasing, there remains a gap in adolescents. Many of them believe that degenerative diseases such as DM only occur in older adults, leading them to neglect daily healthy behaviors (Young et al., 2002). Poor dietary balance, frequent consumption of sugary drinks and fast food, and reluctance to exercise are concrete examples of risky behaviors. This phenomenon is further exacerbated by high exposure to social media and digital technology, which encourage sedentary behaviors. Thus, there is a discrepancy between the knowledge adolescents should have about healthy lifestyles and their actual daily practices (Rodriguez-Moran & Guerrero-Romero, 2006; Zamani et al., 2021).

On the other hand, there is a research gap concerning the limited studies on the relationship between adolescent lifestyle and the risk of type 2 DM, especially in Indonesia. Most studies have focused more on adult populations or groups with a DM diagnosis, while research among adolescents remains relatively limited. In fact, preventive interventions would be far more effective if initiated during adolescence, as this stage is a transitional period for forming lifelong lifestyle habits (Ouyang et al., 2023; Phan et al., 2020). Furthermore, previous studies often emphasized only one aspect of lifestyle, such as diet or physical activity, and therefore have not provided a comprehensive overview of the interrelation between various lifestyle aspects and DM risk in adolescents (Anjana et al., 2009; Pulgaron & Delamater, 2014).

The urgency of this research is underscored by the findings of Indonesia's Basic Health Research (Riskesdas), which show an increasing prevalence of DM year by year, even among younger populations (Sanjaya & Setiawan, 2024). If this phenomenon is

not addressed seriously, it will result in a growing economic and social burden due to high morbidity and mortality in the future. Senior high school students, as a group that is actively shaping their lifestyle, are a strategic target for preventive efforts. By understanding how their lifestyles are related to the risk of type 2 DM, schools, healthcare providers, and parents can develop more targeted intervention strategies.

The novelty of this research lies in its focus on adolescents at SMA Negeri 1 Kota Jambi, by assessing three main lifestyle aspects simultaneously: dietary patterns, physical activity, and smoking habits and their relationship with the risk of type 2 DM. This comprehensive approach provides added value compared to previous studies that examined only one aspect. Moreover, this study emphasizes the local context of adolescents in Jambi, thus offering relevant insights in line with local sociocultural conditions. This is important because adolescent lifestyles are influenced by environmental, cultural, and accessibility factors related to food and physical activity facilities, which may differ across regions.

The purpose of this study is to analyze the relationship between lifestyle including dietary patterns, physical activity, and smoking habits and the risk of type 2 DM among adolescents at SMA Negeri 1 Kota Jambi. Through this objective, the study is expected to provide a more comprehensive understanding of how lifestyle contributes to increasing or decreasing the risk of type 2 DM in adolescents. Furthermore, it aims to identify which lifestyle aspect is most dominant, so it can serve as the basis for designing more specific and effective intervention programs.

The benefits of this study are both theoretical and practical. Theoretically, it enriches the scientific literature on risk factors of type 2 DM among adolescents, particularly in the Indonesian context. Practically, the results can serve as a reference for schools in designing health promotion and nutrition education

programs, for healthcare professionals in delivering more targeted counseling, and for parents in paying closer attention to their children's dietary and physical activity habits. Additionally, the study can support local governments in formulating adolescent health policies based on evidence (evidence-based policy).

Thus, research on the relationship between lifestyle and the risk of type 2 DM in adolescents not only has academic significance but also broad practical implications. Early prevention through the promotion of healthy lifestyles in adolescents is expected to reduce the incidence of type 2 DM in the future. The results of this study can also serve as the foundation for further research, such as specific interventions for lifestyle behavior change among adolescents, which may gradually help curb the increasing prevalence of DM in Indonesia.

MATERIALS & METHODS

This research employed an observational analytic study with a cross-sectional design. This design was chosen because it is suitable for assessing the relationship between lifestyle variables including dietary patterns, physical activity, and smoking habits and the risk of type 2 Diabetes Mellitus (DM) at a single point in time within the adolescent population. The study was conducted at SMA Negeri 1 Kota Jambi in 2025, with all data collection activities carried out in the school environment, particularly in classrooms and the School Health Unit (UKS), which was provided as the research site.

The population in this study consisted of all actively enrolled students at SMA Negeri 1 Kota Jambi in 2025. From this population, a total of 92 respondents were selected using purposive sampling. This technique was chosen because the researchers applied specific inclusion criteria to ensure that respondents were truly relevant to the study objectives. The inclusion criteria were adolescents aged 14–18 years, actively registered as students, willing to participate

by signing informed consent, and able to complete the questionnaire independently. The exclusion criteria included students who were acutely ill during data collection, refused or withdrew from participation, or had incomplete data on key variables.

Independent variables in this study included three lifestyle aspects: dietary patterns, physical activity, and smoking habits. Dietary patterns were assessed using a food frequency questionnaire covering fruit and vegetable consumption, fast food, sugary drinks, and breakfast habits, and then categorized as good or poor. Physical activity was measured using the International Physical Activity Questionnaire (IPAQ-short form), which assessed the frequency and duration of daily or weekly activities, and categorized as sufficient (meeting the criteria of at least 30 minutes/day or 150 minutes/week) or insufficient. Smoking habits were assessed through a direct question on smoking status, categorized as smoker or non-smoker. The dependent variable was the risk of type 2 DM, determined by family history of type 2 DM, Body Mass Index (BMI) based on anthropometric measurements, and hypertension history when supporting data were available. Respondents were classified as at risk if they had at least one of these indicators, while those who did not meet the criteria were considered not at risk.

The instruments used in this study included the lifestyle questionnaire, a digital scale for measuring body weight, and a microtoise for measuring height. BMI was calculated by dividing body weight (kg) by squared height (m²) and categorized according to adolescent BMI standards. The questionnaire was validated by experts and tested for reliability in a pilot study, while the anthropometric instruments were calibrated in advance to ensure accuracy.

Data collection was carried out in several stages. The researchers first obtained permission from the school and ethical approval from the relevant institution. Then, students were informed about the objectives and benefits of the study. Those who agreed

and signed informed consent proceeded to the next stage. Respondents filled out the lifestyle questionnaire independently, with assistance provided by the researchers when needed. Anthropometric measurements (body weight and height) were then taken to calculate BMI, and family history of DM or hypertension was recorded based on respondents' answers. Collected data were then compiled and entered into data processing software.

Data analysis was performed using IBM SPSS Statistics (e.g., version 25). Univariate analysis was used to describe respondent characteristics and the distribution of each research variable in frequency and percentage tables. Bivariate analysis was conducted to examine the relationship

between each lifestyle aspect (dietary patterns, physical activity, and smoking habits) and the risk of type 2 DM using the Chi-square test. If cells with frequencies less than five were found, alternative tests such as Fisher's exact test or continuity correction were applied. In addition, multivariate analysis using binary logistic regression could be employed to determine the most dominant factor influencing the risk of type 2 DM, with results presented as Odds Ratios (OR) and 95% confidence intervals. The statistical significance threshold used was $\alpha = 0.05$, with results considered significant if the p-value < 0.05 .

RESULT

Table 1. Respondents' Characteristics

Characteristics	Frequency	Percentage (%)
Age		
14–16 years	87	94.6
17–18 years	5	5.4
Gender		
Male	63	68.5
Female	29	31.5
Family history of Type 2 DM		
Yes	66	71.7
No	26	28.3
Family history of Hypertension		
Yes	15	16.3
No	77	83.7
Body Mass Index (BMI)		
Not overweight	85	92.4
Overweight	3	3.3
Obesity Grade I	1	1.1
Obesity Grade III	3	3.3

Table 1 presents the characteristics of the respondents. Based on age, the majority of respondents were in the 14–16-year age group, totaling 87 individuals (94.6%), while only 5 respondents (5.4%) were aged 17–18 years. In terms of gender, most respondents were male, amounting to 63 individuals (68.5%), while females accounted for 29 individuals (31.5%). Regarding family history, 66 respondents (71.7%) had a family history of type 2 DM,

whereas 26 respondents (28.3%) did not. A family history of hypertension was reported in 15 respondents (16.3%), while the majority, 77 respondents (83.7%), had no such history. Based on Body Mass Index (BMI), most respondents were not overweight, comprising 85 individuals (92.4%), while 3 respondents (3.3%) were overweight, 1 respondent (1.1%) had obesity grade I, and 3 respondents (3.3%) had obesity grade III.

Table 2. Distribution of Research Variables

Variables	Frequency	Percentage (%)
Dietary Patterns		
Poor	67	72.8
Good	25	27.2
Physical Activity		
Sufficient	43	46.7
Insufficient	49	53.3
Smoking Habits		
Non-smoker	87	94.6
Smoker	5	5.4

Table 2 presents the distribution of respondents based on dietary patterns, physical activity, and smoking habits. Most respondents had poor dietary patterns, totaling 67 individuals (72.8%), while only 25 respondents (27.2%) had good dietary patterns. In terms of physical activity, the

majority fell into the insufficient category with 49 individuals (53.3%), while 43 respondents (46.7%) engaged in sufficient activity. Regarding smoking habits, most respondents were non-smokers, amounting to 87 individuals (94.6%), and only 5 respondents (5.4%) reported smoking.

Table 3. Relationship between Dietary Patterns, Physical Activity, Smoking Habits, and the Risk of Type 2 DM among Adolescents

Variables	Risk of Type 2 DM		p-value
	At risk (n/%)	Not at risk (n/%)	
Dietary Patterns			0.000
Poor	14 (56.0%)	11 (44.0%)	
Good	3 (4.5%)	64 (95.5%)	
Physical Activity			0.030
Sufficient	2 (4.7%)	34 (69.4%)	
Insufficient	15 (30.6%)	41 (95.3%)	
Smoking Habits			0.615
Non-smoker	17 (19.5%)	70 (80.5%)	
Smoker	0 (0.0%)	5 (100%)	

Table 3 shows that dietary patterns are significantly associated with the risk of type 2 DM ($p=0.000$), where 56% of respondents with poor dietary patterns were at risk, while 95.5% of those with good dietary patterns were not at risk. Physical activity also showed a significant relationship ($p=0.030$), with 30.6% of respondents who had insufficient activity being at risk, while the majority of those with sufficient activity were not at risk. In contrast, smoking habits were not associated with the risk of type 2 DM ($p=0.615$), as most respondents, both smokers and non-smokers, were categorized as not at risk.

DISCUSSION

This study aimed to examine the relationship between lifestyle factors—

including dietary patterns, physical activity, and smoking habits and the risk of type 2 DM among adolescents at SMA Negeri 1 Kota Jambi. The findings indicate that the main objective of the study was achieved, as significant associations were found between dietary patterns and physical activity with the risk of type 2 DM. In contrast, smoking habits did not show a meaningful association. Thus, this study successfully provided a clear picture of the lifestyle aspects that most strongly influence the risk of type 2 DM in adolescents.

The results revealed that poor dietary patterns were significantly associated with the risk of type 2 DM ($p=0.000$). Respondents with poor dietary patterns had a higher proportion of being at risk (56%) compared to only 4.5% among those with

good dietary patterns. This indicates that diet is one of the strongest determinants in increasing the risk of type 2 DM in adolescents. These findings are consistent with nutritional theories that emphasize that high intake of simple sugars and saturated fats, combined with low fiber intake, can trigger insulin resistance and obesity as major predisposing factors for type 2 DM (Ruze et al., 2023; Veit et al., 2022).

This study is consistent with previous research by Ra (2022), which found that a high-calorie and low-fiber diet in adolescents increased the risk of type 2 DM by 2.5 times compared to adolescents with healthy diets. Similar results were reported by Li et al. (2020), who stated that there was a significant association between fast-food consumption and increased fasting blood glucose levels in adolescents. This correlation reinforces the assumption that nutritional interventions beginning at school age are an effective preventive strategy to reduce the risk of type 2 DM in the future.

Physical activity was also found to be significantly associated with the risk of type 2 DM ($p=0.030$). About 30.6% of respondents with insufficient physical activity were categorized as at risk, while only 4.7% of those with sufficient activity were at risk. These results confirm that physical activity is an important protective factor against type 2 DM. Sufficient physical activity can improve insulin sensitivity, help control body weight, and reduce visceral fat accumulation, which is a major trigger for glucose metabolism disorders (Oppert et al., 2021; Richter et al., 2021).

In contrast to the other two variables, smoking habits did not show a significant association with the risk of type 2 DM ($p=0.615$). The findings showed that both smokers and non-smokers were mostly in the non-risk category. This may be due to the low prevalence of smoking in the sample, as only 5 respondents (5.4%) reported smoking. The small sample size in this subgroup may have affected the strength of the statistical analysis.

Nevertheless, this result is not entirely consistent with the existing literature. A study by Liu et al. (2022) found that smokers had a higher risk of type 2 DM compared to non-smokers, due to the toxic effects of nicotine on insulin resistance. However, in the context of this study, the impact of smoking habits may not yet be evident because respondents were relatively young and had a short smoking duration. Therefore, although not statistically significant, smoking habits may still be considered a potential risk factor in the future if the behavior continues (Oba et al., 2020).

This study makes an important contribution to promotive and preventive efforts for type 2 DM among adolescents. The finding that dietary patterns and physical activity are closely related to type 2 DM risk reinforces the urgency of balanced nutrition education and increased physical activity in schools. Schools can integrate healthy canteen programs, regular exercise, and health education to shape healthy habits from an early age. The study also emphasizes that adolescents need to be a primary target for public health interventions, as they are in the phase of forming lifelong lifestyle habits.

This study has several limitations. First, the cross-sectional design cannot determine causal relationships, but only associations. Second, data on dietary patterns, physical activity, and smoking habits were collected through questionnaires, which may have introduced subjectivity or recall bias. Third, the number of respondents who smoked was very small, making the analysis of this variable less representative. Finally, the study was conducted at a single school in Jambi City, so the results may not be generalizable to adolescents in other regions with different sociocultural contexts.

CONCLUSION

This study demonstrates that lifestyle plays an important role in determining the risk of type 2 Diabetes Mellitus (DM) among adolescents at SMA Negeri 1 Kota Jambi.

Among the three lifestyle aspects examined, dietary patterns and physical activity were found to be significantly associated with the risk of type 2 DM, while smoking habits did not show a meaningful association.

Adolescents with poor dietary patterns had a higher risk of type 2 DM compared to those with good dietary patterns. Similarly, adolescents with insufficient physical activity were at greater risk compared to their physically active counterparts. Meanwhile, the low number of respondents with smoking habits may have been one of the factors leading to the absence of a significant association for this variable.

Declaration by Authors

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