



Dietary patterns and diabetes mellitus risk in Indonesian adolescents: A literature review

Pola makan dan risiko diabetes melitus pada remaja Indonesia: Tinjauan literatur

Aulia Diva Azzahra^{1*}, Hayu Iyaka Nastaina²

¹ Dietitian Profession Study Program, Faculty of Health Science, Universitas Brawijaya, Jawa Timur, Indonesia.

E-mail: auliadiva@student.ub.ac.id

² Nutrition Department, Faculty of Health Sciences, Universitas Brawijaya. Jawa Timur, Indonesia.

E-mail: hayu.iyaka@ub.ac.id

*Correspondence Author:

Dietitian Profession Study Program, Faculty of Health Science, Universitas Brawijaya, Jawa Timur, Indonesia.

E-mail: auliadiva@student.ub.ac.id

Article History:

Received: May 26, 2025; Revised: August 14, 2025; Accepted: August 15, 2025; Published: March 07, 2026.

Publisher:



Politeknik Kesehatan Aceh
Kementerian Kesehatan RI

© The Author(s). 2026 **Open Access**

This article has been distributed under the terms of the *License Internasional Creative Commons Attribution 4.0*



Abstract

Adolescents in Indonesia increasingly consume high-sugar, saturated fat, and ultra-processed foods, contributing to a rising risk of type 2 Diabetes Mellitus (DM). Low attention to healthy eating and poor awareness of its impact remain major gaps in the literature. This systematic review aimed to determine the association between dietary patterns and DM risk among adolescents and promote early prevention. A systematic review was conducted using Google Scholar, PubMed, ScienceDirect, and ProQuest with the following inclusion criteria: discussing the influence of diet on DM among Indonesian adolescents, written in English or Indonesian, published between 2020-2025, full-text and open access, and excluding reviews, theses, dissertations, or proceedings. Selection followed the PRISMA method, yielding six studies for analysis. The results showed that adolescents consuming sugary drinks >3 times/week had a 2.91 higher risk of abnormal blood glucose, while similar soft drink intake increased the risk of obesity (OR = 8.53), which is directly linked to type 2 DM. Most adolescents also failed to meet the daily fruit and vegetable intake recommendations. In conclusion, adolescent diets are high in sugar and low in fiber, worsened by poor nutritional literacy. School- and family based interventions, restriction of sugary drink availability, and promotion of fruit and vegetable consumption are recommended for early DM prevention.

Keywords: Adolescents, diabetes mellitus, dietary pattern, eating habits.

Abstrak

Perubahan pola makan remaja di Indonesia cenderung tinggi gula, lemak jenuh, dan makanan ultra-proses berkontribusi pada peningkatan risiko Diabetes Melitus (DM) tipe 2. Rendahnya perhatian terhadap pola makan sehat dan minimnya kesadaran akan dampaknya menjadi kesenjangan utama. Studi ini bertujuan untuk mengidentifikasi hubungan pola makan dengan risiko DM pada remaja serta mendorong pencegahan sejak dini. Metode menggunakan *systematic review* menggunakan *database Google Scholar, PubMed, ScienceDirect* dan *ProQuest* dengan kriteria: membahas pengaruh pola makan terhadap DM pada remaja di Indonesia, berbahasa Indonesia atau bahasa Inggris, terbit tahun 2020-2025, dapat diunduh full text dan open access, serta bukan review, thesis atau disertasi, dan proceeding. Seleksi artikel menggunakan metode PRISMA, menghasilkan 6 studi yang dianalisis. Hasil menunjukkan remaja yang mengonsumsi minuman manis >3 kali/minggu berisiko 2.91 kali lebih tinggi mengalami kadar gula darah tidak normal, sementara konsumsi *soft drink* dengan frekuensi sama meningkatkan risiko obesitas (OR = 8.53) yang terkait langsung dengan DM tipe 2. Mayoritas remaja juga tidak memenuhi rekomendasi konsumsi buah dan sayur harian. Kesimpulannya, kebiasaan makan remaja cenderung tinggi gula dan rendah serat, diperburuk oleh rendahnya literasi gizi. Intervensi berbasis sekolah dan keluarga,

pembatasan akses minuman bergula, serta promosi konsumsi buah dan sayur direkomendasikan sebagai pencegahan dini DM.

Kata Kunci: Remaja, diabetes melitus, pola makan.

Introduction

Non-communicable diseases have received significant attention at both national and global levels. One of these diseases that contributes significantly to global mortality rates is diabetes mellitus (DM). The International Diabetes Federation (IDF) estimates that by 2050, approximately 852 million adults worldwide will live with diabetes, or approximately one in eight adults (International Diabetes Federation, 2025). Although DM is generally associated with old age, current trends show an increase in the prevalence of type 2 DM in individuals of productive age, including children and adolescents. This phenomenon is also observed in Indonesia.

Data from the Indonesian Pediatric Society (IDAI) in January 2023 recorded a drastic increase in DM cases among children, which was 70 times higher than in previous years, with a total of 1,645 cases in 13 major cities. This is a cause for concern because adolescence is a critical period in the formation of eating habits and lifestyle, which will have an impact on long-term health. In contrast, data from the Centers for Disease Control and Prevention (CDC) in 2021 showed that the prevalence of DM in the United States among adolescents was estimated to reach 5.7%, with 352,000 adolescents \leq 20 years old and 1.7 million adolescents \geq 20 years old.

One of the main factors contributing to the increase in diabetes among adolescents is unhealthy eating patterns. Adolescents tend to consume fast food, snacks from school canteens, and sweetened beverages that are high in calories, saturated fat, and added sugar but low in fiber, vitamins, and minerals (Azkiya & Fairuza, 2023). Changes in family lifestyles and the influence of the social environment have led to a decrease in the consumption of home-cooked meals and an increase in the consumption of fast food among adolescents (Widiya et al., 2025).

This is in line with the research by Bardhan et al. (2024), which showed that a Western-style diet or junk food has a significant association with an increased risk of DM, particularly through the pathway of increased body mass index and insulin resistance. Additionally, high consumption of sweetened beverages is associated with a 1.3-fold increase in the risk of

prediabetes (Moon et al., 2022) and contributes to 133,000 deaths from DM globally (Fatmala et al., 2022).

As a chronic disease with a continuously increasing global prevalence, DM is gaining more attention, especially among adolescents. Various studies have indicated that adolescents' dietary patterns significantly impact the risk of DM. However, to date, few systematic studies have collected and analyzed scientific evidence on the relationship between dietary patterns and the risk of DM among Indonesian adolescents. The lack of nutritional literacy and awareness of the consequences of dietary patterns are among the factors that exacerbate this risk, but they have not been fully described. Therefore, this systematic review aimed to systematically review the relationship between dietary patterns and the risk of diabetes mellitus in Indonesian adolescents by identifying key findings and various primary studies in the last five years. This study is expected to fill this knowledge gap and provide scientific contributions as a basis for developing more effective and evidence-based prevention strategies.

Methods

Data Sources and Search Strategy

The research design applied in this article is a systematic review using a search, selection, and analysis approach based on the PRISMA guidelines. The selected articles were studies related to the effect of diet on the risk of DM in adolescents in Indonesia. Articles were searched using Google Scholar, Pubmed, Sciene Direct, and ProQuest databases.

Based on the research topic, the researchers used a search strategy employing Boolean operators, namely "food pattern" OR "eating habit" AND "diabetes" OR "diabetes mellitus" OR "type 2 diabetes" AND "adolescent" OR "teenagers" OR "youth" AND "Indonesia". The stages of searching and selecting articles were carried out following the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) framework, which consists of four main stages: identification, screening, eligibility, and inclusion.

To maintain the quality of the article search and selection, researchers used a critical appraisal tool tailored to the type of study (AXIS Tool for cross-sectional study methodologies, both descriptive and correlational).

Eligibility Criteria

The inclusion criteria for article searches were 1) discussing the effect of dietary patterns related to DM in adolescents in Indonesia, 2) Manuscripts in Indonesian and English, 3) articles published in 2020-2025, 4) articles that can be downloaded in full text and open access articles, and 5) articles that are not review journals, theses or dissertations, and proceedings.

Data Extraction

The research flow was conducted using the PRISMA (Preferred Reporting Items for Systematic Review and Meta Analysis (PRISMA) technique (Figure 1), with four stages: identification, screening, eligibility, and inclusion.

In the first stage, 707 articles were identified through database searches using predetermined keywords. Next, in the screening stage, the abstracts were checked to determine whether the articles were relevant to the topic and the criteria. In the eligibility stage, 20 journals were selected based on predetermined inclusion and exclusion criteria. Articles that did not meet the inclusion criteria were excluded from the analysis process or not included in the next stage. Subsequently, the research results that did not specifically study adolescents in Indonesia and did not discuss the direct relationship between diet and DM were eliminated, resulting in six journals at the inclusion stage. Data extraction was performed by researchers using a table containing basic study information and main findings. The data were synthesized narratively using a thematic approach by grouping the findings based on the main themes that emerged from each study.

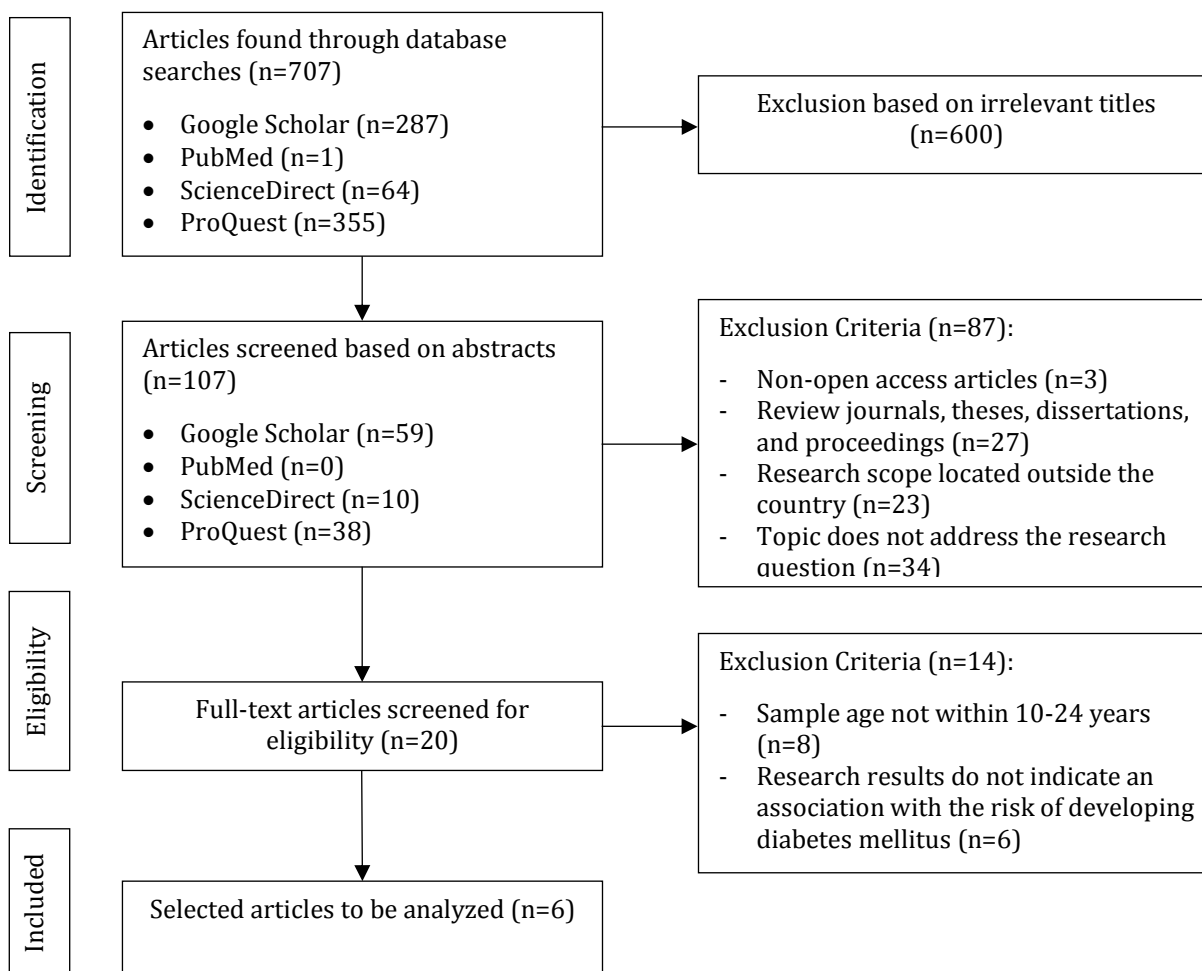


Figure 1. Article search flow using the PRISMA metho

Result and Discussion

The results of the literature review on the correlation between dietary patterns and the risk of DM in adolescents in Indonesia showed that six relevant studies were included in the analysis. The results of this study showed that unhealthy eating habits, including consumption of foods and beverages high in sugar, avoidance of vegetables and fruits, and consumption of instant foods, affect the risk of DM in adolescents. In addition, the risk of diabetes mellitus in adolescents is influenced by their level of knowledge about diet. The results are summarized in Table 1.

Eating Habits in Adolescents

Currently, the eating patterns of adolescents are dominated by packaged foods, snacks, and fast food, replacing traditional diets rich in complex carbohydrates and fiber (Dianah et al., 2022). A review of six studies showed that most adolescents consume foods such as sweetened beverages, packaged snacks, and fried foods more frequently and rarely consume sufficient amounts of fruits and vegetables.

The consumption pattern of sweetened beverages and the low intake of vegetables and fruits among Indonesian adolescents did not occur by chance but rather resulted from the interaction between social influences, media exposure, and poor nutritional literacy. Susanti et al. (2024) showed that peer pressure and advertising are the main triggers for sweetened beverage consumption among adolescents. These results point to the importance of subjective norms and peer role models, which are in line with the principles of the Theory of Planned Behavior, wherein a person's behavior is influenced by social norms and intentions formed from their social environment (Carfora et al., 2021). In line with, exposure to mass media, especially advertisements for sweet products, reinforces poor consumption behaviors, especially among adolescents with low nutritional knowledge. This shows that there is a gap between the availability of information and the processing of information by adolescents, which leads to the formation of unhealthy eating habits in adolescents. Additionally, more than

85% of adolescents do not meet the minimum consumption of five servings or 400 g of vegetables and fruits per day, which can increase the risk of non-communicable diseases such as diabetes mellitus (DM) (Yuningrum et al., 2021). This condition proves that adolescents' eating patterns tend to be formed passively, influenced by their environment rather than by awareness or self-control.

Family roles are a strong determinant of adolescent eating habits (Mahmood et al., 2021). Eating together as a family and support in providing healthy food at home can positively influence the quality of adolescents' diets (Ramli et al., 2021). This indicates that the role of parents as role models is important in determining children's eating tendencies. Conversely, peer influence tends to encourage unhealthy food choices (Susanti et al., 2024). This may occur because adolescents tend to follow their group's preferences to gain social acceptance (Zhang et al., 2022). These findings underscore the importance of household-based interventions and family nutrition education, as well as school nutrition promotion, which transforms peer pressure into support for healthy food choices.

Teenagers' eating habits are often characterized by behaviors that are inconsistent with the principles of balanced nutrition and frequent consumption of snacks between main meals (Ira & Chao, 2022). This diet is high in protein, fat, simple carbohydrates, and salt but low in fiber. This shift disregards the principles of balanced nutrition and has a negative impact on health (Dianah et al., 2022). Irregular eating habits and poor nutritional quality during adolescence not only affect the current nutritional status but also increase the risk of overweight and obesity, which are major risk factors for non-communicable diseases, including type 2 diabetes (Al Rahmad, 2021; Al Dweik et al., 2022). In line with the findings of Jasińska et al. (2021), adolescents with unhealthy eating patterns tend to have excessive energy intake, low fiber intake, and high added sugar intake, which, in the long term, contribute to the development of insulin resistance, dyslipidemia, and metabolic syndrome.

Table 1. The effect of dietary patterns on the risk of diabetes mellitus in adolescents

Researcher and Year	Title and Subject of Research	Research Method	Results and Conclusions
Susanti et al (2024)	Research title: The Relationship between	This was a quantitative,	Adolescents who frequently consume sugary drinks tend to be

	Consumption of Artificial Sweetened Beverages and Risk Factors for Diabetes in Adolescents at Alwasliyah Pancur Batu Private Islamic Junior High School Research subjects: 30 male and female respondents aged 12-14 years	cross Sampling technique: simple random sampling	more overweight than those who rarely consume them.
Lutfiawati (2021)	Research title: The Relationship Between Knowledge of Eating Patterns and Diabetes Risk Factors in Adolescents Research subjects: Adolescents aged 16-17 years - Female: 49 respondents - Males: 23 respondents	This study used a quantitative, descriptive correlation. Sampling technique: proportionate stratified random sampling	There was a significant relationship ($p < 0.05$) between dietary knowledge and DM risk factors. Adolescents with low dietary knowledge are at a greater risk of developing DM.
Halim et al (2024)	Research title: Relation Between Soft Drink Consumption and Obesity in Adolescents Research subjects: High school students - Female: 97 respondents - Males: 101 respondents	This was a quantitative, cross Sampling technique: consecutive	Soft drink consumption among adolescents (more than three times per week) significantly increased the risk of obesity ($p < 0.05$). In addition, individuals with low physical activity levels were 36 times more likely to be obese than those with moderate or high physical activity levels.
Yuningrum et al (2021)	Research title: Risk Factors for Non-Communicable Diseases (NCDs) in Adolescents: A Case Study of Public and Private High Schools in Yogyakarta City Study subjects: High school and vocational school students aged 16-18 years - Female: 35 respondents - Males: 25 respondents	Quantitative descriptive	Most respondents' vegetable and fruit consumption habits were poor (< 5 servings per day). Fast food consumption habits were mostly poor (almost every day). The risk of DM and other non-communicable diseases may increase due to daily habits, such as eating fast food and rarely consuming fruits and vegetables.
Kunsah et al (2023)	Research title: Screening Blood Glucose Levels at Adolescents in Rongtengah Village, Sampang District Study subjects: Adolescents aged 17-20 years - Female: 23 respondents - Males: 19 respondents	This was a quantitative descriptive, observational analytical study. Sampling technique: purposive sampling	A total of 5 out of 42 respondents had high blood glucose levels (> 130 mg/dL). The results of the study showed that several factors, such as genetics, physical activity (not exercising), unhealthy lifestyles, and habits of consuming sweet foods, instant foods, and ready-to-drink beverages, caused an increase in blood glucose levels in adolescents.

Ramli et al (2021)	Research title: Prevention of Type 2 Diabetes Mellitus Among Adolescents in Ternate City, Indonesia Study subjects: Adolescents aged 15-19 years - Female: 236 respondents - Males: 158 respondents	This was a quantitative, cross Sampling technique: purposive sampling	The results of the study are based on an analysis of the KAP (Knowledge, Attitude, and Practice) answers and questions. The results showed that the respondents had a good level of knowledge, attitude, and practice regarding type 2 diabetes prevention, with percentages of 53.8%, 72.6%, and 76.4%, respectively. However, most adolescents continue to exhibit KAP errors in terms of lifestyle, including a lack of physical activity and consumption of healthy foods.
--------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

The Influence of Dietary Patterns on Diabetes Risk

A literature review revealed a consistent pattern in which high consumption of simple sugars, low fiber intake, and a predominance of fast food are the main determinants of increased DM risk in Indonesian adolescents. Adolescents who consume sugary drinks > 3 times/week are 2.91 times more likely to have abnormal blood sugar levels than those who rarely consume them (Susanti et al., 2024). This finding is reinforced by Halim et al. (2024), who found that consuming soft drinks more than thrice a week increases the risk of obesity with an OR of 8.53, which is epidemiologically directly related to type 2 DM.

The high consumption of simple sugars, especially sweetened beverages, is a major problem. The high sugar content in sweetened beverages increases the glycemic load, which triggers weight gain, glucose intolerance, and insulin resistance (Tseng et al., 2021). Mechanistically, fructose-sweetened beverages tend to have a more detrimental effect on insulin sensitivity in the liver, whereas glucose-sweetened beverages are more harmful to insulin sensitivity in the muscles (Hieronimus et al., 2024). Excessive consumption of sweetened beverages has also been associated with increased markers of glucose metabolism, such as fasting glucose levels, insulin, HOMA-IR (an indicator of insulin resistance), and HbA1c, which can ultimately lead to prediabetes (Moon et al., 2022).

The Western dietary pattern is characterized by a high consumption of energy-dense but nutrient-poor foods, such as fast food, processed foods, and red meat and its derivatives

(Clemente-Suárez et al., 2023). Given that the Western diet is generally prepared using high-temperature techniques such as frying and baking, it is suspected that Western dietary intake and the risk of DM are also influenced by harmful compounds produced during the Maillard reaction, such as advanced glycation end products (AGEs) (Quan et al., 2021). Consumption of AGEs from food can activate the Receptor for Advanced Glycation End Products (RAGE), which triggers oxidative stress and inflammation, thereby disrupting insulin signaling pathways and contributing to the development of insulin resistance and type 2 DM (Khalid et al., 2022).

Another factor that strengthens this relationship is the low intake of vegetables and fruits. Yuningrum et al. (2021) reported that 85% of adolescents did not meet the minimum recommended intake of 400 grams/day, and this behavior was significantly associated with an increase in risk factors for non-communicable diseases, including DM. The results of a study by Ramli et al. (2021) added that low nutritional knowledge contributes to poor eating patterns, while family-based interventions can improve eating habits. These findings are relevant because adolescents' lack of attention to healthy eating patterns is not only a matter of preference but also a result of low awareness of long-term risks.

Adolescents show minimal attention to healthy eating patterns and have low awareness of their impact on the risk of DM (Liu et al., 2022). They generally lack knowledge about the recommended daily intake of fruits and vegetables, which may be due to a lack of information in textbooks and public health

education (Moro et al., 2023). This lack of knowledge leads adolescents to mistakenly believe that they are meeting nutritional recommendations, leaving them at risk of non-communicable diseases despite efforts to promote healthy eating (Partridge et al., 2025). Knowledge about choosing healthy snacks is also limited, and high-sugar snacks are more popular (Liu et al., 2022).

In comparison, emphasized the role of packaged beverage consumption, instant foods, and low physical activity in increasing blood glucose levels, while Lutfiawati (2021) highlighted low knowledge and balanced nutritional behavior as predictors of DM. This difference in focus shows that some studies emphasize behavioral and socio-cognitive factors, while others emphasize biological and metabolic factors. However, both agree that the combination of high sugar consumption and fiber deficiency is a dietary pattern that physiologically reduces insulin sensitivity through hepatic lipogenesis, increased free fatty acids (FFAs), and the release of pro-inflammatory adipokines.

The limitations of the analyzed studies include the predominance of cross-sectional designs, which cannot prove a causal relationship between diet and DM risk. In addition, there was variation in the instruments used to measure nutritional knowledge, eating behavior, and physical activity levels between studies. These differences in instruments may affect the consistency and comparability of the results. The potential for recall bias is also quite high, given that most dietary intake data were obtained through food frequency questionnaires (FFQ) or 24-hour recall interviews, in which respondents may be inaccurate in reporting the types and amounts of food consumed. In addition, the heterogeneity of the research context, such as differences in characteristics between adolescents in urban and rural areas, can affect their eating behaviors, access to healthy foods, and responses to interventions. Consequently, findings from one region cannot necessarily be generalized to the entire adolescent population in Indonesia, requiring caution in their application to national policy.

Preventive Measures for Diabetes Mellitus

A review of the six articles analyzed shows that the prevention of type 2 DM in adolescents

requires comprehensive lifestyle behavioral changes, including healthy eating patterns, increased physical activity, and improved nutritional knowledge. The findings of Lutfiawati (2021) showed a significant relationship between nutrition knowledge and the risk of DM in adolescents ($p < 0.05$), with a tendency toward unhealthy eating patterns among respondents with low knowledge. These findings are in line with those of Ramli et al. (2021), who reported weaknesses in the aspects of Knowledge, Attitude, and Practice (KAP), particularly in fruit and vegetable consumption and physical activity, which are major obstacles to preventive efforts.

Type 2 DM can be prevented through lifestyle changes (Hardianto, 2021). In addition, a lack of knowledge about how to prevent DM can also lead to an increase in the incidence of DM (Fitriyani & Kurniasari, 2022). The risk of developing type 2 DM can be reduced by maintaining a healthy diet, namely, by consuming foods high in fiber, eating more fruits and vegetables, and consuming less sugar (Maimunah et al., 2020).

Dietary patterns are the primary focus of these interventions. Fiber intake plays a crucial role in the prevention and management of type 2 diabetes through mechanisms that improve the blood glucose balance. A high-fiber diet can modulate the composition of the gut microbiota to be healthier, which in turn helps improve insulin sensitivity and maintain stable blood glucose levels (Putri et al. 2024). In line with the results of a study by Yen et al. (2022), the intervention group that received intensive coaching to increase vegetable intake in patients with type 2 DM experienced an average HbA1C reduction of 3.1% in 12 weeks, which was greater than that of the control group, which only decreased by 2.3% ($p < 0.05$).

Improvements in the clinical condition of patients with type 2 DM can be achieved by strengthening the antioxidant defense system, either through the use of antioxidant supplements or by increasing the consumption of fruits and vegetables in the daily diet (Wronka et al., 2022). Fruits and vegetables are natural sources rich in vitamin C and polyphenols, which, when consumed in adequate amounts, can help protect the body from the effects of oxidative stress, thereby contributing to a reduced risk of developing DM and complications in the cardiovascular system (Hsia et al., 2020).

Additionally, a high-protein diet offers various benefits, such as improving lipid profiles, aiding in blood glucose control, and lowering blood pressure, making it potentially effective in the prevention and management of diabetes (Pivovarova-Ramich et al., 2020).

In addition to diet, physical activity is an important determinant of health. The results of studies by Kunsah et al. (2023) and Ramadhani et al. (2022) showed that a lack of physical activity increases the risk of DM. A combination of physical activity and a proper diet can delay or even prevent the progression of prediabetes to type 2 DM (Wronka et al., 2022). A physical activity of 150 min per week combined with a 7% reduction and maintenance of initial body weight can reduce the risk of type 2 DM by up to 58%, whereas physical activity alone reduces it by 44% (American Diabetes Association Professional Practice Committee, 2022). Physical activity can reduce the risk of DM because it plays a role in reducing body weight and improving insulin sensitivity (Ramadhani et al., 2022). Physical activity, which involves the movement of skeletal muscles and requires energy, plays a role in controlling blood sugar levels (Putri et al., 2022). Lutfiawati (2021) stated that there is a correlation ($p < 0.05$) between the level of knowledge about dietary patterns and risk factors for DM. In line with the results of a study by Ramli et al. (2021), most adolescents still have errors in the aspects of Knowledge, Attitude, and Practice (KAP) in terms of lifestyle, including lack of physical activity and consumption of healthy foods. People with higher education are more likely to have extensive knowledge (Ulya et al., 2023). Additionally, people with higher levels of education generally have longer life expectancy and better health conditions because they tend to have wider access to health information and a better understanding of the application of healthy living practices (Wahyuni, 2024) ..

Knowledge can encourage people to adopt a healthy lifestyle. Similarly, it is important to take action to prevent diabetes. Therefore, it is crucial to understand the definition, signs and symptoms, risk factors, and prevention efforts for this disease. Early prevention of type 2 diabetes requires knowledge, attitudes, and actions that are interrelated and impact each other, including during adolescence. A good understanding of type 2 DM influences a person's attitudes and actions in maintaining their health. With the right understanding, a person can take the appropriate steps to prevent the development of this disease

and improve their health status (Ramli et al., 2021).

When comparing studies, there are differences in their focus. Susanti et al. (2024) and Halim et al. (2024) place more emphasis on behavioral factors related to consumption (sweetened beverages and fast food), while Lutfiawati (2021) and Ramli et al. (2021) emphasize cognitive and educational aspects. This synthesis indicates that preventive efforts are most effective when family- and school-based nutrition education, restricting access to high-sugar foods/drinks in adolescent environments, and establishing peer support communities for physical activity are combined.

Conclusion

Unhealthy eating patterns among Indonesian adolescents characterized by high consumption of sugary drinks more than three times per week, low intake of fruits and vegetables less than 400 g per day, and a predominance of fast food—have been shown to increase the risk of metabolic disorders. These conditions include obesity, insulin resistance, and abnormal blood sugar levels, which can develop into type 2 diabetes mellitus in the long term. Social factors such as peer influence, exposure to advertising, and low nutritional knowledge also exacerbate these eating habits. Conversely, family support can be an important protective factor in preventing unhealthy eating patterns.

Recommendations include the need for multisectoral interventions, encompassing the integration of evidence-based nutrition education into school curricula and School Health Programs (UKS), the creation of access to and promotion of sugary drinks in school environments, the improvement of access to and affordability of fruits and vegetables through collaboration with local suppliers, and the involvement of families in nutrition education programs to reinforce healthy eating behaviors at home.

Further research is needed using longitudinal studies or intervention trials to confirm the causal relationship between dietary patterns and the risk of DM in adolescents, given that most of the studies analyzed used a cross-sectional design. Standardization of instruments for measuring eating behavior and physical activity is also necessary to make the results of studies more comparable. In addition, studies

that consider the differences between urban and rural contexts will help formulate more targeted policies.

Acknowledgments

The researchers would like to thank those who contributed to this literature review. We would also like to express our gratitude to previous researchers who have provided the scientific basis that has become the foundation for this study. We would like to thank Brawijaya University for its support in providing access to a wide range of literature, which was very helpful in analyzing the topic of this study. This support was essential for completing this study.

References

- Al Dweik, R., Sheble, Y., Ramadan, H., Issa, H., & Sheble, A. (2022). The association between sleeping behavior, obesity, psychological depression, and eating habits among adolescents in the emirate of Abu Dhabi-United Arab Emirates. *PLOS ONE*, *17*(8), e0269837. <https://doi.org/10.1371/journal.pone.0269837>
- Al Rahmad, A. H. (2021). Several risk factors of obesity among female school teachers and relevance to non-communicable diseases during the Covid-19 pandemic. *Amerta Nutrition*, *5*(1), 31–40. <https://doi.org/http://dx.doi.org/10.20473/amnt.v5i1.2021.31-40>
- American Diabetes Association Professional Practice Committee. (2022). Prevention or delay of type 2 diabetes and associated comorbidities: Standards of Medical Care in Diabetes—2022. *Diabetes Care*, *45*(Suppl 1), S39–S45. <https://doi.org/10.2337/dc22-S003>
- Azkiya, F., & Fairuza, F. (2023). Hubungan antara kepatuhan minum obat pasien diabetes mellitus dan dukungan yang diberikan keluarga. *Jurnal Ilmiah*, *4*(2), 45–51. <https://doi.org/10.60010/jikd/v4i2.79>
- Bardhan, S., Mondal, S., & Mukherjee, S. (2024). Dietary intake and risk of diabetes: A study in Bengalee young adult females. *Brazilian Journal of Development*, *10*(6), e70489. <https://doi.org/10.34117/bjdv10n6-030>
- Carfora, V., Cavallo, C., Catellani, P., Del Giudice, T., & Cicia, G. (2021). Why do consumers intend to purchase natural food? Integrating theory of planned behavior, value-belief-norm theory, and trust. *Nutrients*, *13*(6), Article 1904. <https://doi.org/10.3390/nu13061904>
- Clemente-Suárez, V. J., Beltrán-Velasco, A. I., Redondo-Flórez, L., Martín-Rodríguez, A., & Tornero-Aguilera, J. F. (2023). Global impacts of Western diet and its effects on metabolism and health: A narrative review. *Nutrients*, *15*(12), Article 2749. <https://doi.org/10.3390/nu15122749>
- Dianah, R., Andari, E. A., Putri, E. A., Dwinanti, C. C., & Nafisah, D. N. (2022). Penyuluhan cara mencegah obesitas pada remaja dengan pola makan yang sehat. *Jurnal Abdimas ADPI Sains dan Teknologi*, *3*(3), 41–50. <https://doi.org/10.47841/saintek.v3i3.220>
- Fatmala, T., Rohmah, M., & Septimar, Z. M. (2022). Hubungan konsumsi minuman berpemanis dengan obesitas pada remaja. *Nusantara Hasana Journal*, *2*(1), 215–220. <https://nusantarahasanajournal.com/index.php/nhj/article/view/341/256>
- Fitriyani, W., & Kurniasari, R. (2022). Pengaruh media edukasi terhadap peningkatan pengetahuan pencegahan diabetes mellitus pada remaja. *Jurnal Untuk Masyarakat Sehat (JUKMAS)*, *6*(2), 190–195. <https://doi.org/10.52643/jukmas.v6i2.2141>
- Halim, Y., Sembiring, T., Sianturi, P., Faranita, T., & Pratita, W. (2024). Relation between soft drink consumption and obesity in adolescents. *Enrichment: Journal of Multidisciplinary Research and Development*, *1*(4), 147–152.
- Hardianto, D. (2021). Telaah komprehensif diabetes melitus: Klasifikasi, gejala, diagnosis, pencegahan, dan pengobatan. *Jurnal Bioteknologi & Biosains Indonesia (JBBI)*, *7*(2), 304–317. <https://doi.org/10.29122/jbbi.v7i2.4209>
- Hieronimus, B., Medici, V., Lee, V., Nunez, M. V., Sigala, D. M., Bremer, A. A., Cox, C. L., Keim, N. L., Schwarz, J. M., Pacini, G., Tura, A., Havel, P. J., & Stanhope, K. L. (2024). Effects of consuming beverages sweetened with fructose, glucose, high-fructose corn syrup,

- sucrose, or aspartame on OGTT-derived indices of insulin sensitivity in young adults. *Nutrients*, 16(1), Article 151. <https://doi.org/10.3390/nu16010151>
- Hsia, D. S., Zhang, D. J., Beyl, R. S., Greenway, F. L., & Khoo, C. (2020). Effect of daily consumption of cranberry beverage on insulin sensitivity and modification of cardiovascular risk factors in adults with obesity: A pilot, randomised, placebo-controlled study. *British Journal of Nutrition*, 124(6), 577–585. <https://doi.org/10.1017/S0007114520001336>
- International Diabetes Federation. (2025). *IDF diabetes atlas* (11th ed.). International Diabetes Federation. <https://idf.org/diabetes-atlas/>
- Ira, I., & Chao, J. C.-J. (2022). The relationship between snack consumption patterns and nutritional status in adolescents in Malang City, Indonesia. *Medical Technology and Public Health Journal*, 5(2), 231–238. <https://doi.org/10.33086/mtphj.v5i2.3187>
- Jasińska, M., Strzelecka, A., Chmielewski, J., Wolak, P., Stanisławska, I., Choina, P., Kordyzon, M., & Nowak-Starz, G. (2021). Quality of life, health, eating habits and physical development of middle school adolescents in the Świętokrzyskie region. *Annals of Agricultural and Environmental Medicine*, 28(4), 659–666. <https://doi.org/10.26444/aaem/141624>
- Khalid, M., Petroianu, G., & Adem, A. (2022). Advanced glycation end products, bone health, and diabetes mellitus. *Biomolecules*, 12(4), Article 542. <https://doi.org/10.3390/biom12040542>
- Kunsah, B., Purwaningsih, N. V., & Puspitasari, T. (2023). Screening blood glucose levels at adolescents in Rongtengah Village, Sampang District. *Mukhtabar: Journal of Medical Laboratory Technology*, 1(2), 39–46. <https://doi.org/10.52221/mjmlt.v1i2.357>
- Liu, K. S. N., Chen, J. Y., Sun, K. S., Tsang, J. P. Y., Ip, P., & Lam, C. L. K. (2022). Adolescent knowledge, attitudes and practices of healthy eating: Findings of qualitative interviews among Hong Kong families. *Nutrients*, 14(14), Article 2857. <https://doi.org/10.3390/nu14142857>
- Lutfiawati, N. (2021). Relationship levels of diet knowledge with diabetes mellitus risk factors in adolescents. *Nusantara Hasana Journal*, 1(6), 15–26.
- Mahmood, L., Flores-Barrantes, P., Moreno, L. A., Manios, Y., & Gonzalez-Gil, E. M. (2021). The influence of parental dietary behaviors and practices on children's eating habits. *Nutrients*, 13(4), Article 1138. <https://doi.org/10.3390/nu13041138>
- Maimunah, S., Asrinawaty, & Rahman, E. (2020). Pengaruh faktor aktivitas fisik, genetik dan pola makan terhadap kejadian diabetes melitus tipe II di RSUD Dr. H. Moch Ansari Saleh Banjarmasin tahun 2020. *EPrints UNISKA*. <http://eprints.uniska-bjm.ac.id/id/eprint/3130>
- Moon, J. Y., Hua, S., Qi, Q., Sotres-Alvarez, D., Mattei, J., Casagrande, S. S., Mossavar-Rahmani, Y., Siega-Riz, A. M., Gallo, L. C., Wassertheil-Smoller, S., Kaplan, R. C., & Corsino, L. (2022). Association of sugar-sweetened beverage consumption with prediabetes and glucose metabolism markers in Hispanic/Latino adults in the United States: Results from the Hispanic Community Health Study/Study of Latinos (HCHS/SOL). *The Journal of Nutrition*, 152(1), 235–245. <https://doi.org/10.1093/jn/nxab334>
- Moro, C., Phelps, C., & McLean, M. (2023). Don't forget the veggies! Identifying and addressing a lack of vegetable education in physiology. *Advances in Physiology Education*, 47(4), 726–731. <https://doi.org/10.1152/advan.00052.2023>
- Partridge, S. R., Mandoh, M., Todd, A. R., Wardak, S., Mautner, D., Yan, F., Phongsavan, P., Redfern, J., Cheng, H. L., Lee, A., Fang, J., Bower, M., Donohoe-Bales, A., Mahrshahi, S., & Raeside, R. (2025). Participation their way: A mixed methods study on engaging Australian adolescents in non-communicable disease prevention. *BMC Public Health*, 25(1). <https://doi.org/10.1186/s12889-025-22969-w>
- Pivovarova-Ramich, O., Markova, M., Weber, D., Sucher, S., Hornemann, S., Rudovich, N., Raila, J., Sunaga-Franze, D., Sauer, S., Rohn, S., Pfeiffer, A. F. H., & Grune, T. (2020). Effects of diets high in animal or plant protein on oxidative stress in individuals

- with type 2 diabetes: A randomized clinical trial. *Redox Biology*, 29, 101397. <https://doi.org/10.1016/j.redox.2019.101397>
- Putri, M. G., Nugroho, H., & Adi, M. S. (2022). Hubungan indeks massa tubuh dan tingkat aktivitas fisik dengan kontrol glikemik diabetes melitus tipe 2. *Jurnal Epidemiologi Kesehatan Komunitas*, 7(1), 341–350. <https://doi.org/10.14710/jekkv7i1.6791>
- Putri, M. P., Lestari, E. S., & Afifah, D. N. (2024). Dietary pattern and gut microbiota in type 2 diabetes mellitus: A literature review. *AcTion: Aceh Nutrition Journal*, 9(3), 611. <https://doi.org/10.30867/action.v9i3.1915>
- Quan, W., Zeng, M., Jiao, Y., Li, Y., Xue, C., Liu, G., Wang, Z., Qin, F., He, Z., & Chen, J. (2021). Western dietary patterns, foods, and risk of gestational diabetes mellitus: A systematic review and meta-analysis of prospective cohort studies. *Advances in Nutrition*, 12(4), 1353–1364. <https://doi.org/10.1093/advances/nmaa184>
- Ramadhani, N. F., Siregar, K. N., Adrian, V., Sari, I. R., & Hikmahrachim, H. G. (2022). Hubungan aktivitas fisik dengan diabetes melitus pada wanita usia 20–25 di DKI Jakarta (analisis data Posbindu PTM 2019). *Jurnal Biostatistik, Kependudukan, dan Informatika Kesehatan*, 2(2). <https://doi.org/10.51181/bikfokes.v2i2.5820>
- Ramli, R., Kurniawan, D., & Rahman, H. R. (2021). Prevention of type 2 diabetes mellitus among adolescents in Ternate City, Indonesia. *Jurnal ISaintika Medika*, 17(2), 100–111. <https://ejournal.umm.ac.id/index.php/sai/med/article/view/15112>
- Susanti, N., Saragih, I. A. P., Sikumbang, E. S., & Faiza, M. (2024). Hubungan antara konsumsi minuman manis buatan dan faktor risiko penyakit diabetes pada remaja di MTs Swasta Alwasliyah Pancur Batu. *PREPOTIF: Jurnal Kesehatan Masyarakat*, 8(2), 3457–3462.
- Tseng, T.-S., Lin, W.-T., Gonzalez, G. V., Kao, Y.-H., Chen, L.-S., & Lin, H.-Y. (2021). Sugar intake from sweetened beverages and diabetes: A narrative review. *World Journal of Diabetes*, 12(9), 1530–1538. <https://doi.org/10.4239/wjd.v12.i9.1530>
- Ulya, N., Sibuea, A. Z. E., Purba, S. S., Maharani, A. I., & Herbawani, C. K. (2023). Analisis faktor risiko diabetes pada remaja di Indonesia. *Jurnal Kesehatan Tambusai*, 4(3), 2332–2341. <https://doi.org/10.31004/jkt.v4i3.16210>
- Wahyuni, R. (2024). Hubungan tingkat pendidikan dan pola pikir orang tua terhadap pola pengasuhan anak. *Nabawi: Jurnal Penelitian Pendidikan Islam*, 1(2), 11. <https://doi.org/10.58577/dimar.v4i2.84>
- Widiya, G. A., Andriyanti, & Lusida, N. (2025). Pengaruh konsumsi fast food terhadap risiko obesitas pada remaja di berbagai negara dan wilayah daerah. *Jurnal Praba: Jurnal Rumpun Kesehatan Umum*, 3(2), 128–140. <https://doi.org/10.62027/praba.v3i2.370>
- Wronka, M., Krzemińska, J., Młynarska, E., Rysz, J., & Franczyk, B. (2022). The influence of lifestyle and treatment on oxidative stress and inflammation in diabetes. *International Journal of Molecular Sciences*, 23(24), Article 15743. <https://doi.org/10.3390/ijms232415743>
- Yen, T. S., Htet, M. K., Lukito, W., Bardosono, S., Setiabudy, R., Basuki, E. S., Wibudi, A., Martianto, D., Subekti, I., & Fahmida, U. (2022). Increased vegetable intake improves glycaemic control in adults with type 2 diabetes mellitus: A clustered randomised clinical trial among Indonesian white-collar workers. *Journal of Nutritional Science*, 11, e41. <https://doi.org/10.1017/jns.2022.41>
- Yuningrum, H., Trisnowati, H., & Rosdewi, N. N. (2021). Faktor risiko penyakit tidak menular (PTM) pada remaja: Studi kasus pada SMA negeri dan swasta di Kota Yogyakarta. *Jurnal Formil (Forum Ilmiah) Kesmas Respati*, 6(1), 41. <https://doi.org/10.35842/formil.v6i1.343>
- Zhang, H., Li, R., Veeck, A., & Yu, H. (2022). Peer influence on teenagers' preference for brand name food products: The mediation effect of peer identity. *International Journal of Consumer Studies*, 46(4), 1099–1112. <https://doi.org/10.1111/ijcs.12746>