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Systematic Literature Review: Consumption Of Sugary Foods And Beverages In Children And The Increased Risk Of Type 2 Diabetes Mellitus

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ABSTRACT

Type 2 diabetes mellitus (T2DM) in children is becoming an increasing global concern due to its rising prevalence, primarily caused by unhealthy dietary patterns. This study aims to systematically review scientific evidence regarding the relationship between the consumption of sugary foods and beverages and the increased risk of T2DM in children. The method used is a Systematic Literature Review of publications from 2016 to 2025, obtained from databases such as PubMed, ScienceDirect, and Google Scholar. The article selection process followed Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines and resulted in seven studies that met the inclusion and exclusion criteria. The review findings indicate that excessive consumption of sugar-sweetened beverages is strongly associated with an increased risk of T2DM. These findings highlight the importance of early intervention through nutrition education, family involvement, and stricter regulation of unhealthy food and beverage marketing to prevent the development of T2DM in children.

Keywords: Food consumption, Children, Diabetes mellitus type 2, Sugar-Sweetened Beverages

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INTRODUCTION

The prevalence of diabetes mellitus (DM) continues to show an increasing trend worldwide, including among children and adolescents. Based on data from the International Diabetes Federation (IDF) in 2021, the number of adults living with diabetes worldwide has exceeded 537 million, and this figure is projected to rise to 643 million by 2030[1]. In Asia, the prevalence of DM reaches 60% in Japan and 50% in Taiwan[2]. Southeast Asia ranks third in the world in terms of the number of people with diabetes mellitus (DM). In Indonesia, data from Riskesdas in 2018 showed that the prevalence of DM among individuals aged ≥15 years reached 10.9%[3].

The 2023 National Health Survey also recorded that type 2 DM dominates cases across all age groups, including adolescents[4]. According to data released by the Indonesian Pediatric Society (IDAI) in January 2023, around 1,645 children in Indonesia were diagnosed with diabetes mellitus, with 5–10% of them being type 2 diabetes. Approximately 46% of these patients were between the ages of 10 and 14, and about 31% were aged 14 years and above[5].

Diabetes mellitus is a group of disorders and is classified as a metabolic disease caused by chronic hyperglycemia resulting from problems in insulin secretion, insulin function, or a combination of both[6]. There are two main types of diabetes mellitus, namely type 1 (T1DM) and type 2 (T2DM). T1DM arises from damage to the pancreatic beta cells, leading to an absolute deficiency of insulin, whereas T2DM is associated with insulin resistance and impaired insulin secretion. Diabetes in children may present as either type 1 or type 2 DM; however, recent trends show a significant increase in type 2 DM.

This condition is closely related to the increasing prevalence of childhood obesity. Diets high in sugar, salt, and fat, along with sedentary lifestyles, are significant risk factors[7]. Among children, the consumption of fast food, junk food, and sugar-sweetened beverages tends to be higher. These foods can slow down the body's metabolism and reduce the number of calories burned, making it more difficult to maintain a healthy weight. The main reasons for preferring fast food and junk food are time efficiency and the appealing taste derived from the high content of oil, salt, and sugar[8]. In addition, lack of physical activity and prolonged screen time further increase the risk of insulin resistance, which can lead to type 2 diabetes. This condition poses a risk of long-term chronic complications. Children with type 2 DM are known to be more vulnerable to nephropathy, retinopathy, neuropathy, and cardiovascular disease at a younger age compared to adult patients[9]. This condition not only affects the quality of life of children and their families but also increases the burden of national healthcare costs[10].

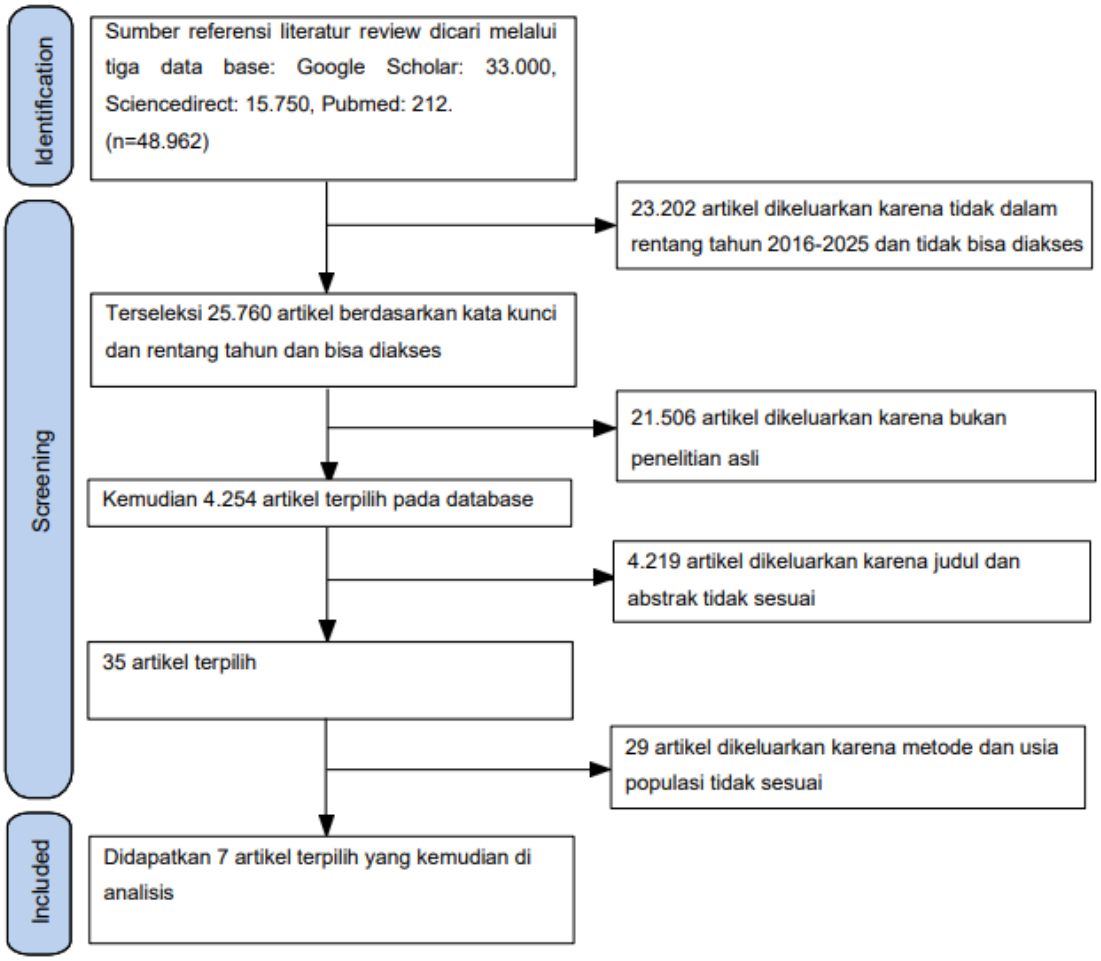
Considering the rising trend of DM cases in children and their significant impact, scientific studies on the risk factors are highly important. Dietary patterns and beverage consumption are among the crucial determinants in the increasing prevalence of type 2 DM. Therefore, this literature review focuses on examining the scientific evidence regarding the relationship between food and beverage consumption and the increased risk of type 2 diabetes in children. The findings are expected to serve as a foundation for designing more effective preventive interventions and to support policies for controlling non-communicable diseases from an early age, in line with the National Action Plan for the Control of Non-Communicable Diseases and the WHO targets for 2025.[4]

METHOD

In this study, a Systematic Literature Review (SLR) approach was employed. This method was chosen because it can provide a comprehensive overview of the available findings while also identifying common patterns and research gaps. The research data were collected on May 9, 2025, from online databases such as PubMed, Science Direct, and Google Scholar. The article search used relevant keyword strategies, including *Food Consumption, Children, Type 2 Diabetes Mellitus, Sugar-Sweetened Beverages*. Data were obtained from scientific articles published between 2016 and 2025 in both Indonesian and English. The inclusion

criteria consisted of original research articles in either English or Indonesian, focusing on children under 18 years of age, and available in full text. Scientific articles in the form of editorial reviews, studies with adult populations, or those inaccessible in full text were excluded. The selection process followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow in a structured and systematic manner.

Gambar 1. Hasil Pencarian Artikel *Literature Review*



RESULTS AND DISCUSSIONS

Based on the article search conducted through three databases, namely Google Scholar, ScienceDirect, and PubMed, a total of 48,962 articles were obtained. Then, 23,302 articles were excluded because they were not within the last 10 years (2016 to 2025). A total of 21,506 articles were excluded because they were not original research but systematic literature reviews. Another 4,219 articles were excluded because their titles and abstracts were not relevant. Subsequently, 29 articles were excluded due to inappropriate methods and population age. In the final stage, 7 articles met the inclusion criteria and were analyzed in this review.

Table 1. Matriks *Literatur Review*

No	Authors, Year	Title	Study Design	Objective	Results
1.	(Nurma Azharil et al., 2025)	The Relationship between Students 'Parents' Knowledge and Attitudes about Type 2 Diabetes Mellitus with Students' Behaviour of Purchasing Snacks from Street Food Vendors at School	Cross Sectional	Mengetahui hubungan antara pengetahuan dan sikap orang tua mengenai DM type 2 dengan kebiasaan siswa membeli jajanan di pedagang kaki lima	Anak usia 15-18 tahun sering membeli jajanan diluar seperti gorengan, minuman manis, makanan cepat saji, secara signifikan meningkatkan risiko DM tipe 2.
2.	(Jannah, A. R., & Humayrah, W. 2024)	Consumption Of Sugar-Sweetened Beverages Increases The Risk Of Diabetes Mellitus Among Adolescents In Bogor City.	Cross Sectional	Menganalisis hubungan konsumsi minuman berpemanis dengan risiko diabetes mellitus pada remaja.	Mengkonsumi SSB>1 kali sehari (360ml) yang ada pada teh manis dan minuman kemasan manis dapat meningkatkan risiko DM 4,583 kali lebih tinggi.
3.	Veridiana & Nurjana, 2019	Hubungan Perilaku Konsumsi dan Aktivitas Fisik dengan Diabetes Mellitus di Indonesia	Cross Sectional	Mengkaji hubungan pola konsumsi dan aktivitas fisik dengan insidensi diabetes melitus di Indonesia, berdasarkan data yang diperoleh dari Riset Kesehatan Dasar (Riskesdas) tahun 2013.	Konsumsi makanan olahan tepung seperti biskuit merupakan faktor risiko DM. Masyarakat yang memiliki kebiasaan mengonsumsi biskuit berpeluang untuk memiliki risiko terkena diabetes melitus 1,198 kali lebih tinggi dibandingkan dengan mereka yang tidak mengonsumsinya.
4.	(Briawan, D., Khomsan, A., Alfiah, E., Nasution, Z., Putri, P.A., 2023)	Preference for and consumption of traditional and fast foods among adolescents in Indonesia	Cross Sectional	Penelitian ini bertujuan untuk mengkaji preferensi dan konsumsi makanan tradisional dan cepat saji di kalangan remaja di Indonesia serta kaitannya dengan faktor sosial, ekonomi, demografi, dan regional.	Fast food minuman berpemanis seperti French fries, burger, ayam goreng, salad buah, sushi, boba, soda dapat meningkatkan risiko DM tipe 2 melalui peningkatan konsumsi gula dan energi berlebih.
5.	(Nafratilova & Wijaya, 2024)	Perilaku Konsumsi Makanan Dan	Deskriptif kuantitatif dengan	Memahami pola konsumsi makanan dan minuman manis	Studi menunjukkan bahwa frekuensi konsumsi makanan dan minuman

No	Authors, Year	Title	Study Design	Objective	Results
		Minuman Manis Anak Usia Sekolah Dasar Di Kota Bengkulu	metode survey	pada siswa sekolah dasar di Kota Bengkulu.	manis pada siswa sekolah dasar adalah setiap hari (36,6%), 2-3 kali seminggu (48,2%), dan sekali seminggu (15,2%). Jenis makanan yang sering dikonsumsi meliputi donat, permen, cokelat, es krim, biskuit, jeli, roti, panekuk, dan pie. Sementara itu, jenis minuman yang banyak dikonsumsi oleh anak-anak adalah es teh manis kemasan, minuman boba, minuman berenergi, jus kemasan, pop ice, dan es cappuccino
6.	(Amin Muzakir Muhammad, 2024)	Tren Minuman Kemasan Dalam Kalangan Siswa Sekolah Tingkat Pertama Dan Dampaknya Terhadap Kesehatan.	Case Study	Eksplorasi tren konsumsi minuman kemasan di kalangan siswa sekolah tingkat pertama serta dampak kesehatan yang diakibatkannya.	konsumsi minuman kemasan yang tinggi pada siswa berhubungan dengan peningkatan prevalensi masalah kesehatan yang serius.
7.	(Nabila Khoirotul Ummah, Suprajitno, Marsaid, Nurul Hidayah., 2024)	Hubungan Pola Makan Dan Aktivitas Fisik Dengan Risiko Terjadinya Diabetes Melitus Pada Remaja Di SMP Negeri 1 Sukosari Kabupaten Bondowoso	Cross Sectional	Untuk mengetahui hubungan antara pola makan dan aktivitas fisik dengan risiko terkena diabetes melitus pada remaja di SMP Negeri 1 Sukosari, Kabupaten Bondowoso	Terdapat korelasi signifikan secara statistik antara preferensi diet dan risiko diabetes melitus pada populasi remaja. Mayoritas responden menunjukkan frekuensi konsumsi yang tinggi terhadap panganan tinggi gula dan lemak, seperti gorengan, cimol, cilok, serta produk makanan dan minuman berkadar gula tinggi

Diabetes mellitus is a chronic metabolic condition characterized by elevated glucose levels above the normal threshold in the bloodstream (hyperglycemia), which occurs due to impaired production or function of the insulin hormone. Insulin itself plays an important role in regulating the absorption of glucose into body cells to be used as an energy source[11]. The occurrence of diabetes mellitus is also influenced by unhealthy lifestyle changes, particularly the excessive consumption of sweetened foods and beverages that can trigger an increase in blood glucose levels. If this condition persists for a long period, it may lead to various diseases, including type 2 diabetes mellitus[12]. A study by Nurma Azharil (2025) indicated that consuming sweetened

foods and beverages significantly increases the risk of type 2 diabetes mellitus among children and adolescents under the age of 18. In addition to consuming sugary drinks, they also frequently consume snacks such as fried foods and fast food, which further increase the risk of developing type 2 diabetes mellitus[13]. These foods and beverages generally contain saturated fats, artificial sweeteners, and high calories, all of which contribute to insulin resistance and impaired glucose metabolism.[14,15]

Meanwhile, the study by Rodhatul Jannah and Humayrah (2024) showed that consuming sugar-sweetened beverages (SSBs) more than once a day in amounts exceeding 360 ml significantly increases the risk of developing type 2 diabetes mellitus by up to 4.583 times (Rodhatul Jannah & Humayrah, 2024). Liquid sugar intake from sweetened drinks is known to rapidly raise blood glucose levels and cause metabolic stress on pancreatic beta cells, which in the long term can trigger diabetes.[17]

According to the study by Khoirotul Ummah et al. (2024), unhealthy dietary patterns have a significant correlation with an increased risk of diabetes mellitus in the adolescent age group. Poor dietary practices, such as the routine consumption of fried foods, cimol, cilok, as well as foods and beverages high in sugar, have the potential to increase susceptibility to the risk of diabetes mellitus. In addition, they rarely consume fruits and vegetables[18]. The lack of fiber intake and nutrients such as vitamins and minerals can lead to overall metabolic disorders in the body. Fiber is an important component in regulating glucose absorption in the blood and supporting digestive health. It also provides a longer-lasting feeling of satiety and helps control appetite, which is essential for weight management and reducing the risk of diabetes.[19]

The findings of Veridiana & Nurjana (2019) stated that the consumption of flour-based processed foods, such as biscuits, is associated with an increased risk of type 2 diabetes mellitus. Individuals who regularly consume biscuits are 1.198 times more likely to develop diabetes mellitus compared to those who do not consume them. Biscuits are classified as processed foods that are high in simple carbohydrates and low in fiber, which can cause spikes in blood glucose levels[20]. This finding is consistent with the study by Yang Hu et al. (2020), which found that high consumption of processed foods, particularly flour-based products with a high glycemic index, is associated with an increased risk of insulin resistance and type 2 diabetes mellitus. The processing reduces fiber and micronutrient content, accelerates glucose absorption, and increases the burden on the pancreas to produce insulin.[21]

Research by Nafratilova & Wijaya (2024) and Amin Muzakir Muhammad (2024) highlighted the high consumption of sweet foods and beverages among children, which is influenced by factors such as age, parental education, family income, and eating habits. The findings showed that most children had the habit of consuming sweet foods and beverages two to three times a week, with 36.6% of them consuming them daily. Frequently consumed sweet foods and beverages included candy, chocolate, sweet cakes, packaged tea, energy drinks, and packaged juice. Some of these products contain high amounts of sugar, such as a 44-gram milk chocolate bar containing about 5.75 teaspoons of sugar, sponge cake with 30–35 grams of sugar per serving, packaged tea with around 20 grams of sugar per serving, candy containing about 90–95 grams of sugar, and milk chocolate with 50–55 grams of sugar. The American Heart Association recommends that children aged two to eighteen years should not consume more than 6 teaspoons (25 grams) of added sugar per

day and should limit sugary drinks to 8 ounces per week.The habit of consuming high-sugar foods and beverages from an early age can shape a preference for sweet tastes that continues into adulthood, increasing the potential for obesity, type 2 diabetes, and other health problems. Therefore, it is important for parents to limit their children's sugar intake and encourage healthy eating patterns to support optimal growth and development.[22 23]

CONCLUSION

Based on the review of various sources, it can be concluded that the consumption of sweetened foods or beverages (SSBs) significantly contributes to the increased risk of type 2 diabetes mellitus among children and adolescents. Poor eating habits, such as frequent consumption of fast food, sugary drinks, and processed foods high in sugar and fat, are closely associated with metabolic disorders that may develop into type 2 diabetes mellitus. Furthermore, the increased risk of type 2 diabetes in children is not only influenced by the foods or drinks consumed but also by environmental factors, family behavior, and social regulations.Comprehensive and sustainable preventive efforts are needed to reduce the risk of type 2 diabetes mellitus in children. Nutrition education from an early age should be strengthened through school curricula and effective public health campaigns. Parental involvement is also essential in shaping healthy eating habits at home. The government needs to tighten regulations related to the marketing of unhealthy foods and beverages that are easily accessible to children. Cross-sector collaboration should be pursued to create an environment that supports healthy lifestyles for children. Through these efforts, the prevalence of type 2 diabetes in children is expected to decline, ensuring better long-term health outcomes.

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