

Review Article



Environmental, Genetic, and Behavioral Associations with the Incidence of Obesity in Primary School Children: A Systematic Review

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ABSTRACT

Background: Obesity is influenced by complex interactions between environmental, genetic, and behavioural factors. This study aims to explore the relationship between these three factors and the incidence of childhood obesity.

Method: A systematic literature review was used following PRISMA guidelines. The data were collected from three main databases: Google Scholar, PubMed, and Garuda. Screening was carried out from 89 articles found until 10 relevant articles were obtained for analysis.

Results: The analysis shows that childhood obesity is influenced by genetic factors, behaviour (including eating habits and physical activity), and environment (such as access to healthy food and sports facilities). These three factors interact to increase the risk of obesity.

Conclusion: This study emphasizes that obesity prevention requires a multidisciplinary approach that involves the roles of family, school, government, and community. Recommended efforts include improving access to nutritious food, education on healthy lifestyles, and creating an environment that supports physical activity. The findings provide important insights for designing more effective interventions to address obesity in primary school-aged children.

Keywords: Obesity; Genetic; Environmental; Behavior; Primary School; Children

INTRODUCTION

Along with the development of the times resulting in nutritional problems in toddlers and children, it is a double problem, namely the discovery of the problem of undernutrition coupled with the discovery of the problem of excess nutrients such as energy, fat and salt.¹ Obesity is an excessive or abnormal accumulation of body fat that increases the risk of health problems. Children who are overweight or obese tend to remain obese into adulthood, potentially

increasing the risk of non-communicable diseases, such as diabetes mellitus and

with the discovery of the problem of excess nutrients such as energy, fat and salt.¹ Obesity is an excessive or abnormal accumulation of body fat that increases the risk of health problems. Children who are overweight or obese tend to remain obese into adulthood, potentially increasing the risk of non-communicable diseases, such as diabetes mellitus and cardiovascular disease, at a young age.² The 2018 Riskesdas data shows that the prevalence of obesity in Indonesian children aged 5-12 years is 9.2% for boys, 10.7%, and for girls, 7.7%.³ According to Hendrik L. Blum (1974), the degree of public health is influenced by factors such as environment, behaviour, health services and heredity; health status will be achieved optimally when the four factors together have optimal conditions, one of which is in a disturbed state (not optimal), the health status will be shifted below optimal.⁴

Obesity occurs when energy intake exceeds energy expenditure because of genetic and environmental changes. In obese individuals, leptin resistance occurs when the body cannot respond to leptin. Leptin is an enzyme vital in maintaining the body's energy balance. It functions to control appetite so that even though food intake is sufficient, obese people cannot control their appetite. Obesity in children can be assessed through various examination methods or techniques, one of which is measuring body mass index (BMI).⁵

Family history factors play an essential role in the development of obesity. Genetic research has identified several genes related to energy metabolism, appetite and fat storage, all of which may influence an individual's risk of obesity. However, genetic factors do not work in isolation. They interact with environmental and behavioural characteristics to influence a person's weight status. Genetics also affect the incidence of childhood obesity. Ancestry has been known to influence the amount of body fat elements and exceed the normal amount. Parents who are obese have a high risk of having obese children.⁶

Obesity is caused by several factors, namely genetic/hereditary factors, dietary factors, socioeconomic status factors and physical activity factors; one of the factors that most influence the occurrence of obesity is physical activity. The rapid development of technology contributes to the increase in the prevalence of obesity; without realizing it, technology accompanies us to a sedentary lifestyle, including lack of physical activity, eating instant food, and consuming less fruit and vegetables; physical activity is any body movement produced by skeletal muscles that requires energy expenditure, Lack of physical activity is an independent risk factor for chronic diseases and overall is estimated to cause death globally.⁷

Weight gain is also closely related to increased intake of *fast food* or *fast food*; fast food in question is packaged, easy to serve, practical or processed. These foods are generally produced by the food processing industry with high technology and provide various additives to preserve and flavour these products. Children's high frequency of fast food can increase calorie deposits in the body, increasing BMI values. In addition, this habit is often exacerbated by low physical activity, which reduces calorie burning, and a genetic predisposition that increases the risk of obesity. *Fast food* is viewed negatively due to its unbalanced nutritional

content, with a high proportion of carbohydrates, fat, cholesterol and salt. In contrast, the content of fibre and other essential nutrients is very low.

Obesity in elementary school-aged children is an increasing health problem that requires serious attention. Various systematic studies have shown that childhood obesity is multifactorial and influenced by genetic, environmental, and behavioural factors. Genetic factors, such as a family history of obesity, contribute to excessive body fat accumulation risk. In addition, environments that do not support healthy lifestyles, such as limited access to nutritious food and exercise facilities, exacerbate the situation. Unhealthy eating behaviours, including fast food that is high in fat and low in fibre, are also significant causes. In this context, obesity is a primary degenerative disease problem that needs immediate attention and concerted efforts from various parties. Primary and tertiary health interventions are required to prevent and overcome obesity. Public health efforts should focus on increasing and facilitating physical activity to overcome the obesity epidemic and encourage people to adopt a healthy and regular diet.

This systematic literature review aims to determine the relationship between environment, genetics, and behaviour to the incidence of obesity in primary school children. It is expected to provide new insights into the factors that influence childhood obesity and become the basis for prevention and treatment interventions. Prevention strategies should be designed to promote healthy lifestyles among children by increasing access to nutritious foods, raising awareness about the importance of physical activity, and building an environment that supports healthy behaviours. In addition, approaches that recognize individual differences and the role of genetics in obesity may aid in developing more personalized interventions and effectively analyze the influence of diet and physical activity on the incidence of obesity.

METHOD

This systematic literature review aims to analyze the relationship between genetic, behavioural and environmental factors on the incidence of obesity in primary school children. The methodology followed the steps of a literature review designed to describe, organize and evaluate previously published scientific articles related to this topic. The process began with formulating the background and objectives of the study, followed by developing research questions to guide the literature search process. The literature search was conducted through several databases, such as Google Scholar, PubMed, and Garuda, and relevant keywords were used. The articles found were examined, categorized, and selected based on predetermined criteria. After the duplicate article elimination process, 10 relevant journals were identified for further analysis. These articles were organized and evaluated based on their quality using pre-defined inclusion and exclusion criteria. Finally, these 10 selected journals were used as the material in the analysis process to support this research.

This study followed the PRISMA (*Preferred Reporting Items for Systematic Reviews and Meta-Analyses*) guidelines during the systematic review process for search results and study selection⁸. A systematic review summarizes primary research results to present more comprehensive and balanced facts. Throughout the process, the *systematic review* method provides a strong basis for exploring the relationship between knowledge, attitudes, and motivation in managing vaccine cold chains by combining existing research results and

presenting them in a systematic and objective manner.

Data Search Strategy

The data search strategy includes methods used to search for information relevant to the research topic. In this case, the plan was carried out using various databases such as Google Scholar, PubMed, and Garuda with the keywords "Obesity," "Genetics," "Environment," "Behavior," and "Primary school children." The purpose of this data search strategy is to identify sources of information relevant to the research topic.

1. Resources

Information sources are places or media where data and information can be found. The primary sources of information used in this research are various databases and scientific literature related to the topic, namely scientific articles obtained from Google Scholar, PubMed, and Garuda. These sources of information are used to collect data relevant to the research.

2. Eligibility Criteria

Eligibility criteria determine whether an information source or article can be included in the research. In this case, the eligibility criteria include topics, source, publication period, language and research design. Only sources that meet these criteria will be included in the analysis.

3. Quality Assessment

Quality assessment is the process of evaluating the quality of sources used in research. In this study, the quality assessment was conducted by reading the abstracts and full manuscripts to assess whether the sources had a clear methodology and were relevant to the research topic.

4. Data Extraction

Data extraction is the process of retrieving relevant information from selected information sources. In this study, data extraction includes retrieving information about the relationship between environmental, genetic, and behavioural factors and the incidence of obesity in primary school children. The extracted data will be used for further analysis.

5. Data Synthesis

Data synthesis is the stage where information from various sources is combined, analyzed, and presented systematically. In this study, data synthesis includes grouping articles based on inclusion and exclusion criteria and analyzing articles that meet these criteria. The following inclusion and exclusion criteria are outlined in Table 1.

Table 1. Inclusion and Exclusion Aspects of Literature in this Study

Aspect	Inclusion	Exclusion
Topic	Articles must focus on the relationship between genetics, behaviour, and environment with obesity among elementary school children.	Articles discussed outside the topic
Type of Research	Scientific articles, empirical research	Articles published in unrecognized journals or sources that cannot be verified or literature review
Period & Language	Published between 2019-2023. Articles written in English or Bahasa	Published outside the range applied and using language apart from Bahasa and English.
Research Design	Articles such as empirical research must have a clear and relevant methodology for the research topic.	Articles lacking a clear methodology or not relevant to the research topic

RESULTS

We yielded 242 articles based on the keywords entered in the databases. The selected articles are the results of relevant studies and by the objectives, in English, international standards, and published in 2019-2024. Exclusion criteria in this literature review are articles that do not examine the variable factors that cause obesity, the age of obese subjects being 7-12 years, articles not in the time range used, and full-text articles that cannot be accessed. The article selection process is presented in Figure 1.

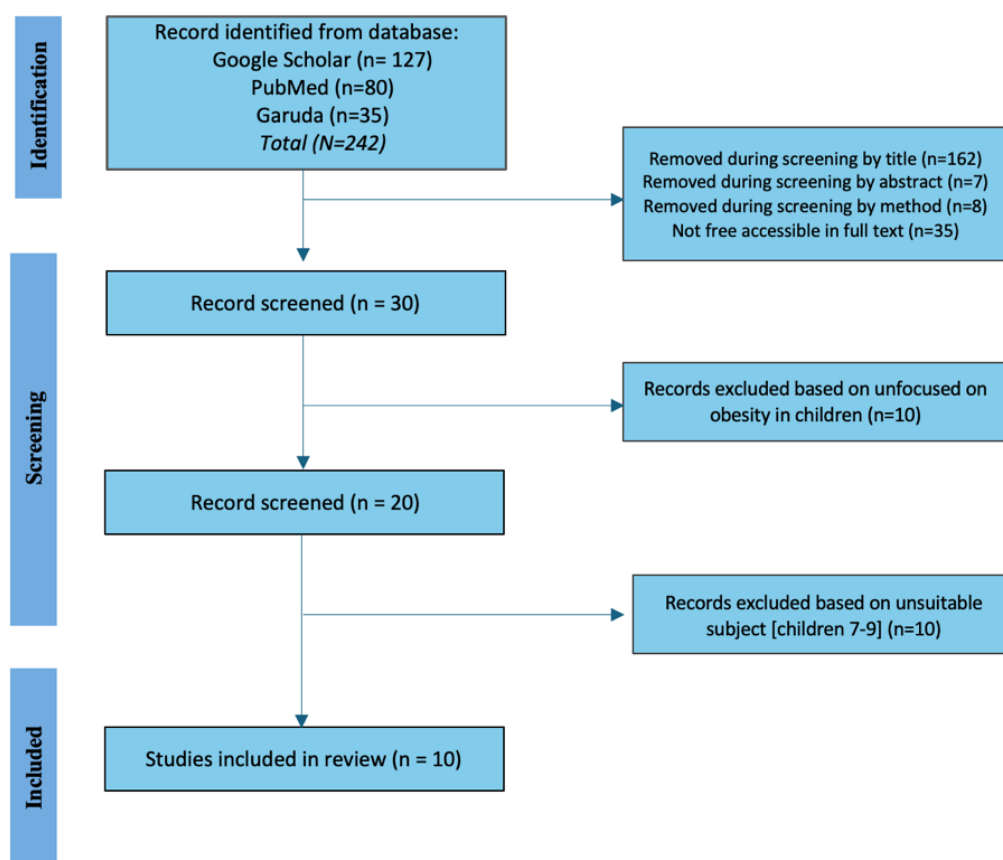


Figure 1. Database search and selection of studies based on PRISMA guidelines

From the selection process, 10 articles were found appropriate and suitable for further review, as presented in Table 2. It has generally been shown that genetic factors play a significant role in increasing the risk of obesity in primary school-aged children. Children who come from families with a history of obesity tend to be more prone to weight problems. Genes that affect the way the body manages energy and regulates appetite can be inherited, so these children have a higher tendency to be obese. Thus, parents need to understand that family health history can be an indicator of risk for childhood obesity, and preventive measures need to be taken early on. In addition to genetic factors, poor eating habits also contribute greatly to the incidence of obesity in children. Analysis shows that many children consume fast food that is high in calories and low in nutrients, which can lead to excess calorie intake. Exposure to unhealthy food advertisements and easy access to fast food exacerbate children's eating patterns.

Therefore, it is essential to educate children on the importance of healthy eating and provide more nutritious food options at home and school to reduce the risk of obesity. Lack of physical activity was also a significant risk factor in this analysis. Many children spend more time on sedentary activities, such as watching television or playing video games than exercising. The study shows that the combination of an unhealthy diet and lack of physical activity creates conditions that favour obesity. Therefore, it is essential to encourage children to be more physically active through regular exercise or outdoor activities to help maintain a healthy weight and improve overall health.

DISCUSSION

Our study found that genetic factors have a significant role in predisposing children to obesity. Research shows that children who have parents with a history of obesity tend to have a higher risk of becoming obese. Specific genes, such as those that affect fat metabolism, can increase a person's tendency to gain weight. Previous study shows that children from families with a history of obesity more often experience excessive body fat accumulation.⁹ This suggests that genetic factors cannot be ignored when understanding the incidence of obesity. Genetic factors are important in determining a person's predisposition to obesity. Research shows that children with obese parents are more likely to be obese themselves due to the presence of genetic predispositions that affect body metabolism and fat storage. Specific genes, such as those that affect the activity of the enzyme lipoprotein lipase (LPL) in fat tissue, can increase a person's tendency to gain weight faster compared to people who do not have similar genetic factors.¹⁰ Obesity is more deadly than malnutrition. Overweight and obesity affect children's health and are major risk factors for mortality¹¹. Genetic and lifestyle factors affecting energy intake led to obesity and other complex health problems. Obese parents are a contributing factor to obesity in students. Pregnancy experienced by obese mothers causes the size of babies born to exceed regular numbers. The cause of this is the increase in the fat element in the body, which is becoming more prominent.

The environment in which children grow and develop also significantly influences the incidence of obesity. Environments that are less supportive of physical activity, such as limited open space for play or lack of sports facilities, can cause children to spend more time in sedentary activities, such as watching television or playing video games. In addition, family and social environments that are less supportive of healthy eating also increase the risk of obesity.¹² Poor

diet, such as fast-food habits or consumption of high-calorie, low-nutrient foods, is often found in families with low education levels or limited income. Children's food consumption is far

Table 2. Data from article included in the review

No	Researchers	Title	Design	Sample	Objective	Results
1	Lisa Agustina, Linda T. Maas, Zulfendri (2019)	Analysis of Risky Behaviors Related to Obesity Among Children Aged 9-12 Years in SD Harapan 1 Medan	Cross-sectional	The sample in this study was 59 respondents selected from all students in grades IV, V, and VI.	The purpose of this study was to analyze risk behavior factors associated with the incidence of obesity in children aged 9-12 years.	Significant risk factors for obesity in elementary school children include eating habits, physical activity, exposure to television advertisements, and pocket money. Of the four factors, pocket money was the dominant factor with a probability of obesity incidence of 80.5% in children who had large pocket money. The study also revealed that 54.2% of the total sample were obese, while 45.8% were not. The study highlighted the need for schools to play a role through programs such as the School Health Unit (UKS) in monitoring children's nutritional status and creating a school environment that supports healthy eating and adequate physical activity. In addition, parental support in managing children's eating and activity habits, as well as limiting exposure to television advertisements, are important steps to prevent obesity early on.
2	Sriwahyuni, Junaidin, Noyumala, Alfiah, Vitarianti Tangkelayuk (2021)	Diet on the Incidence of Obesity in Children	Cross-sectional	The samples in this study were all fourth and fifth grade children at SD Frater Bakti Luhur Makassar whose body weight was more than normal. The number of samples used in this study were 30 people	This study aims to understand how children's fast-food diet can affect their nutritional status and contribute to obesity cases.	Children's diet, especially the consumption of fast food more than twice per week, is significantly associated with the incidence of obesity. Of the total 30 children at SD Frater Bakti Luhur Makassar, 86.7% were obese, while the remaining 13.3% were overweight. Children who frequently consume fast food, both at school and outside the home, tend to have a higher risk of obesity. This fast-food consumption generally includes foods high in calories, fat, salt, and low in fiber. Environmental factors such as the availability of school canteens that sell fast food contribute to the high consumption of this type of food. In addition, family habits, such as frequent meals at fast food restaurants, also increase the risk of obesity in children. This study emphasizes the important role of families and schools in monitoring children's diets, including providing healthy food alternatives and limiting children's access to fast food. This is expected to reduce the prevalence of obesity and maintain children's health in the long run.
3	Shinta Maharani, Rice Hernanda (2020)	Factors associated with obesity	Cross-sectional	The sample in this study were all students at SDN 10 Semende Darat	The aim of this study was to identify and understand the factors that influence the incidence of obesity among school-aged children.	Most children were not obese (81.0%), with most respondents being female (55.8%), having adequate sleep duration (<8.5 hours, 65.5%), and light physical activity (82.2%). Analysis showed no association between gender and obesity (p-value =

No	Researchers	Title	Design	Sample	Objective	Results
		In School-Age Children		Laut Muara Enim Regency, which numbered 163 students.		0.092). However, a significant association was found between sleep duration (p-value = 0.034) and physical activity (p-value = 0.004) with the incidence of obesity. This study concluded that insufficient sleep duration and low physical activity are associated with the incidence of obesity. It is recommended that schools improve monitoring of children's nutritional status through health programs such as the School Health Unit (UKS) to prevent obesity.
4	Justiyulfa Syah, Desy, Afif D Alba, Zulikha (2021)	Relationship between Diet and Lifestyle with the Occurrence of Obesity in Children Aged 7-12 Years in Flamboyant Lot in Batam City in 2021	Cross-sectional	The sample in this study was 56 respondents consisting of children aged 7-12 years who lived in Flamboyant Lot, Batam City in 2021.	The purpose of this study is to analyze the relationship between diet and lifestyle with the occurrence of obesity in children aged 7-12 years in Flamboyant Lot, Batam City in 2021.	Most obese children have an unbalanced diet, characterized by consumption of foods high in calories and low in fiber. The lifestyles of obese children also tend to be less physically active, with more free time spent on sedentary activities such as watching television or playing games. Statistical analysis showed a significant association between unhealthy diet and sedentary lifestyle with the incidence of obesity in children (p-value <0.05). A diet high in fast food consumption and low in fruit and vegetable consumption contributed significantly to obesity. Poor diet and sedentary lifestyle are the main risk factors for obesity in school-age children.
5	Elsi Rahmadani, Pawiliyah, Novi Ade Suryani, Suryani (2022)	The Relationship of Physical Activity, Parental History and Diet with the Incidence of Obesity in Children in Elementary School	Cross sectional	The sample in this study consisted of 52 school-age children who were in grades 4 and 5 at MIN 2 Bengkulu City.	The aim of this study focuses on school-aged children, specifically in grades IV and V to explore how two key factors-physical activity and diet-contribute to the growing problem of obesity among children.	Most obese children have low levels of physical activity, with more time spent on sedentary activities such as watching television or playing gadgets. A history of obesity in parents was also found to contribute significantly to the incidence of obesity in children, indicating the role of genetic factors and family habits. In addition, an unbalanced diet, such as consumption of foods high in calories, low in fiber, and frequent consumption of fast food, was also strongly associated with childhood obesity. Statistical analysis showed a significant association between these three factors-physical activities (p-value < 0.05), parental history of obesity (p-value < 0.05), and diet (p-value < 0.05)-with the incidence of childhood obesity.
6	Nourmayansa Vidya Anggraini (2022)	Parental Education and School-Age Childhood Obesity	Cross sectional	The sample in this study was 242 students selected by simple random sampling technique from SD X Depok, with an	The purpose of this study was to determine whether there is a relationship between parental education and the incidence of obesity in school-age children. This study focuses on students at SD X Depok, where more than 30% of students are obese. In addition, this study also considers the impact	Parents' education level plays an important role in children's diet and lifestyle. Parents with lower education levels tend to have less knowledge about balanced nutrition, resulting in uncontrolled diets, with consumption of high-calorie and low-fiber foods more common. In contrast, parents with higher education generally have a better understanding of the importance of a healthy diet and physical activity, which results in a reduced risk of childhood

No	Researchers	Title	Design	Sample	Objective	Results
				age range of 7 - 11 years.	of the COVID-19 pandemic that causes children to stay at home more, thus reducing physical activity and increasing snacking habits, which contribute to weight gain. By analyzing the relationship between parental education and childhood obesity, this study aims to provide insights into how education levels can affect parental knowledge regarding nutrition and healthy eating, which in turn can impact children's nutritional status.	obesity. Statistical analysis showed a significant association between parental education level and the incidence of childhood obesity (p-value <0.05). Children of parents with low education level have a higher risk of obesity compared to children of highly educated parents.
7	Rr. Maghfira Nadia P, Sri Wahyuni, Sigit Ambar Widiyawati (2019)	The Relationship between Physical Activity and the Incidence of Obesity in School Children in Mardi Rahayu Ungaran Elementary School Semarang Regency	<i>Cross sectional</i>	The sample in this study were 108 students attending SD Mardi Rahayu Ungaran.	The detailed objective of this study was to determine the relationship between physical activity and the incidence of obesity in school children at SD Mardi Rahayu Ungaran, Semarang Regency. This study aims to analyze how much influence physical activity has on the level of obesity among students, as well as provide recommendations to increase physical activity in schools as an effort to prevent obesity.	Obese children have low levels of physical activity. These children tend to spend more time on sedentary activities, such as watching television, playing gadgets, or studying without being balanced with adequate exercise or physical activity. In contrast, children with moderate to high physical activity have a lower risk of obesity. Statistical analysis showed a significant association between physical activity and the incidence of obesity in school children (p-value <0.05). Children with low physical activity have a higher chance of being obese than children with adequate or high physical activity.
8	Nourmayansa, Vidya Anggraini, Ritanti, Diah Ratnawati (2022)	Genetic Influences on the Incidence of Obesity in School-Aged Children	<i>Cross sectional</i>	The sample in this study was 242 students who were students in grades 1 - VI at SD X Depok, with the inclusion criteria that the students were active.	The detailed objective of this study is to determine whether genetics affect obesity in school-age children. This study focuses on the relationship between genetic factors and the incidence of obesity among SD X Depok students.	Genetic factors play an important role in the incidence of obesity in school-aged children. Children who have parents with a history of obesity or overweight tend to have a higher risk of developing obesity. Further analysis shows that children from families with a history of obesity more often experience excessive body fat accumulation, leading to obesity. In addition to genetic factors, family life habits, such as unhealthy diet and lack of physical activity, were also found to contribute to the incidence of childhood obesity. However, the results indicate that genetic factors are the main determinant in the incidence of obesity in school-aged children.
9	Zefanya Marsella Sumael, Achmad Paturusi, Agusteivie Telew (2020)	Relationship between Physical Activity and the Incidence of Obesity at	<i>Cross sectional</i>	The sample in this study consisted of 85 people who were taken through the total sampling technique from all	The purpose of this study was to analyze and determine the relationship between physical activity and the incidence of obesity in Pangolombian Health Center. This study aims to provide a better understanding of how physical activity levels can affect the	Obese individuals have low levels of physical activity. They tend to spend more time on sedentary activities, such as watching television or playing gadgets, without doing enough exercise or physical activity. In contrast, individuals with high levels of physical activity show a lower prevalence of obesity. Statistical analysis using the chi-square test showed a significant

No	Researchers	Title	Design	Sample	Objective	Results
		Pangolombian Health Center		patients visiting the Pangolombian Health Center in September 2020.	incidence of obesity in the population studied, as well as to provide information that can be used in obesity prevention efforts in the region.	association between physical activity and the incidence of obesity (p-value <0.05). Individuals with low physical activity have a higher risk of obesity compared to individuals who are more physically active.
10	Nadiya Zia Nurhaliza, Zuraidah Nasution, Ramadhani Syafitri Nasution (2023)	Factors Associated with the Incidence of Obesity in School Children at Sdn 002 Sapat Kuala Indragiri Riau District in 2021	<i>Cross sectional</i>	The sample in this study were all grade I, V, and VI students at SDN 002 Sapat, Kuala Indragiri District, totaling 79 people, with the sampling technique using total sampling.	The purpose of this study was to analyze the relationship between several factors, such as maternal education, physical activity, and genetics, with the incidence of obesity in school children at SDN 002 Sapat, Kuala Indragiri District. This study aims to identify factors that have a significant effect on childhood obesity, as well as to provide recommendations based on the results of the analysis conducted.	Factors associated with the incidence of childhood obesity in the school. The first factor found was diet. Children with unbalanced eating habits, such as consuming high amounts of fast food and sugary drinks, have a greater risk of obesity. In addition, lack of physical activity also contributes to the incidence of obesity. Children who spend more time in sedentary activities, such as watching television or playing games, tend to be overweight. Another factor that also plays a role is a family history of obesity. Children who have parents or family members with obesity or overweight problems show a higher prevalence of obesity. Family socio-economic factors also play a role, with families with higher socio-economic status tending to provide more access to high-calorie foods and less attention to healthy eating.

removed from their preference for vegetables and fruits. Children tend to prefer *fast food*, flavoured foods, and soft drinks. These foods are high in calories and fat, which accelerates obesity in children.¹³ Prior research revealed that poor dietary patterns, such as the consumption of high-calorie fast food, are often found in families with low education levels or limited income. Social and economic environments that are less supportive of healthy eating also increase the potential for obesity. Social and economic environments that are less supportive of healthy eating also increase the potential for obesity.¹⁴

Children's eating behaviour and physical activity are two essential aspects that greatly influence the incidence of obesity. Unhealthy eating habits, such as consumption of high-calorie *foods*, frequent consumption of *junk food*, and overeating, are among the main factors. Low physical activity also contributes significantly to fat accumulation in the body, as the incoming energy is not burned correctly. In addition, the duration of time spent on activities such as playing *gadgets* or watching television can increase the risk of obesity because the incoming calories are not balanced with the energy expended.¹⁵ Children's eating behaviour and physical activity are two essential aspects that greatly influence the incidence of obesity. Unhealthy eating habits, such as consuming foods high in calories, low in fibre, and low in physical activity, contribute significantly to fat accumulation in the body. Previous research showed that children with an unbalanced diet and lifestyle have a higher risk of obesity.¹⁶ In addition, the duration of time spent on activities such as watching television or playing *with gadgets* also contributes to the increased risk of obesity.

Obesity is caused by eating too much carbohydrate, fat, or protein and lack of physical activity. Obesity in adolescents is significant to note because adolescents who are obese are 80% likely to become obese as adults. In addition, high BMI in adolescents is predicted to increase the risk of death and cardiovascular disease. Obese adolescents may suffer from comorbidities such as type 2 diabetes mellitus, liver disease, metabolic syndrome, and cardiovascular disease.¹⁷ It is essential to understand the interaction between these factors. Childhood obesity is not caused by just one factor but by a complex interaction between genetics, environment, and behaviour. Previous research emphasizes the importance of understanding how these three factors interact to develop more effective prevention strategies. For example, children who have obese parents and grow up in an environment that does not support healthy eating and physical activity tend to have a higher risk of obesity.¹⁸

Preventing childhood obesity requires a multidisciplinary approach that involves the roles of families, schools, government and communities. Recommended efforts include increasing access to nutritious food, education about healthy lifestyles, and creating an environment that supports physical activity. Previous research also showed that parental education is essential in children's diet and lifestyle.¹⁹ Parents with higher education levels tend to understand better the importance of a healthy diet, which reduces the risk of obesity in children. Thus, a better understanding of the relationship between these factors may help design more effective interventions to prevent and address obesity in primary school-aged children.²⁰ This study provides important insights for devising more comprehensive and sustainable prevention strategies.

CONCLUSION

Obesity in primary school-aged children is a complex health problem that is influenced by the interaction between genetic, environmental and behavioural factors. This study used a systematic literature review method to analyze the relationship between these three factors and found that children with a family history of obesity have a higher risk of becoming obese. In addition, unsupportive environments, such as lack of access to healthy food and exercise facilities, as well as unhealthy eating habits, such as consumption of high-calorie fast food, contribute significantly to the incidence of obesity.

Declarations

Authors' contribution

NA, SS, and SAM equally contributed to the design of the study. NA completed the data collection and analysis and wrote the first draft. SS and SAM reviewed the draft.

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Conflict of interest

There is no conflict of interest in this research.

REFERENCES

1. Sekar Ayu D, Woro Kasmini Handayani O. Diary Teratas (Obese Children Therapy) in Changing Nutrition Behavior of Elementary School Students. *Unnes J Public Heal*. 2016;5(2):167-75. Available from: <https://journal.unnes.ac.id/sju/ujph/article/view/10125>
2. Suryamulyawan KA, Arimbawa IM. Prevalence and characteristics of obesity in children at Saraswati V Elementary School in Denpasar City in 2016. *Medical Science Digest*. 2019;10(2):342-6. Available from: <https://smtpauth.isainsmedis.id/index.php/ism/article/view/393/320>
3. Zamzani M, Hadi H, Astiti D. Aktivitas fisik berhubungan dengan kejadian obesitas pada anak Sekolah Dasar. *J Gizi dan Diet Indones (Indonesian J Nutr Diet)*. 2017;4(3):123. Available from: <https://ejournal.almaata.ac.id/index.php/IJND/article/view/339>
4. Notoatmodjo S. Health education and behavior. Jakarta: Rineka Cipta; 2023.
5. Mulyana, L., & Farida, E. Pola pemberian makan yang tepat dalam mengurangi risiko obesitas pada balita. *J Ners*. 2022;5(2):42-50. Available from: <https://journal.unnes.ac.id/sju/IJPHN/article/view/51661>
6. Lee JS, Jin MH, Lee HJ. Global relationship between parent and child obesity: a systematic review and meta-analysis. *Clin Exp Pediatr*. 2022 Jan 1;65(1):35–46. Available from: <https://pmc.ncbi.nlm.nih.gov/articles/PMC8743427/pdf/cep-2020-01620.pdf>
7. Ferdianti L. Literature Review: Hubungan Aktivitas Fisik dan Kebiasaan Konsumsi Makanan Cepat Saji dengan Kejadian Obesitas pada Anak Sekolah Dasar. *Media Kesehatan Masyarakat Indonesia*. 2021;20(2):139-43. Available from:

8. <https://ejournal.undip.ac.id/index.php/mkmi/article/view/35624>
O'Dea RE, Lagisz M, Jennions MD, Koricheva J, Noble DWA, Parker TH, et al. Preferred reporting items for systematic reviews and meta-analyses in ecology and evolutionary biology: a PRISMA extension. *Biol Rev.* 2021;96(5):1695-722. Available from: <https://pubmed.ncbi.nlm.nih.gov/33960637/>
9. Jebeile H, Kelly AS, O'Malley G, Baur LA. Obesity in children and adolescents: epidemiology, causes, assessment, and management. Vol. 10, *The Lancet Diabetes and Endocrinology*. Elsevier Ltd; 2022. p. 351–65. Available from: <https://pmc.ncbi.nlm.nih.gov/articles/PMC9831747/pdf/main.pdf>
10. Nicklas BJ, Rogus EM, Berman DM, Dennis KE, Goldberg DKE. Responses of adipose tissue lipoprotein lipase to weightloss affect lipid levels and weight regain in women. *Am J Physiol Endocrinol Metab.* 2000; 279(5). Available from: <https://journals.physiology.org/doi/epdf/10.1152/ajpendo.2000.279.5.E1012>
11. Maharani S, Hernanda R. Faktor yang berhubungan dengan kejadian obesitas pada anak usia sekolah. *J Ilm Multi Sci Kesehat.* 2020;12(2):285-99. Available from: <http://jurnal.stikes-aisyiyah-palembang.ac.id/index.php/Kep/article/view/513/0>
12. Ayala GX, Monge-Rojas R, King AC, Hunter R, Berge JM. The social environment and childhood obesity: Implications for research and practice in the United States and countries in Latin America. *OBESITY.* 2021; 22(S3). Available from: <https://pmc.ncbi.nlm.nih.gov/articles/PMC8365653/pdf/OBR-22-e13246.pdf>
13. Pavilianingtyas A. Faktor agen, pejamu, dan lingkungan penyebab obesitas pada anak usia 5-6 tahun. *The Indones J Nutr.* 2017;5(2):105-11. Available from: <https://ejournal.undip.ac.id/index.php/jgi/article/view/16587/12104>
14. Nurwanti E, Hadi H, Julia M. Paparan iklan junk food dan pola konsumsi junk food sebagai faktor risiko obesitas pada anak sekolah dasar di perkotaan dan pedesaan di Daerah Istimewa Yogyakarta. *Indonesian J Nutr Diet and Nutrition.* 2016;1(2):59. Available from: <https://ejournal.almaata.ac.id/index.php/IJND/article/view/41/0>
15. Suza DE, Miristia V, Hariati H. Physical activities and incidence of obesity among adolescents in Medan, Indonesia. *Open Access Maced J Med Sci.* 2020;8(4):198-203. Available from: <https://oamjms.eu/index.php/mjms/article/view/4225>
16. Nadia P RM, Wahyuni S, Ambar Widiyawati S. Hubungan aktivitas fisik dengan kejadian obesitas pada anak sekolah di Sd Mardi Rahayu Ungaran Kabupaten Semarang. *J Holistics Heal Sci.* 2019;1(1):65-78. Available from: <https://e-abdimas.unw.ac.id/index.php/jhhs/article/view/13>
17. Sriwahyuni, Junaidin, Noyumala, Alfiah A, Tangkelayuk V. Pola Makan Terhadap Kejadian Obesitas Pada Anak. *J Kesehatan Ibu dan Anak.* 2021;6(2):91–8. Available from: <https://journal.unisa-bandung.ac.id/index.php/jaia/article/view/268>
18. Justiyulfah, Alba AD, Zulikha. Hubungan pola makan dan gaya hidup dengan kejadian obesitas pada anak usia 7-12 tahun di Kavling Flamboyan di Kota Batam tahun 2021. *J Ilmu Kedokt dan Kesehat Indones.* 2021;1(1):66-84. Available from: <https://journal.amikveteran.ac.id/index.php/jikki/article/view/2090>
19. Anggraini NV, Ritanti, Ratnawati D. Pengaruh genetik terhadap kejadian obesitas pada anak usia sekolah. *J Heal Educ Lit Fak Ilmu Kesehatan Univ Pembang Nas Veteran Jakarta.* 2022;5:1-7. Available from: <https://journal.arikesi.or.id/index.php/Vitamin/article/view/721>
20. Sandalayuk M, Arda ZA, Hafid W, Badu FD, Harun A, Akbar H, et al. Determinan obesitas pada anak sekolah dasar. *Haga Journal of Public Health.* 2024; 2(1). Available from: <https://journal.victoryhaga.org/index.php/hjph/article/view/37>