Literasi Kesehatan Husada: Jurnal Informasi Ilmu Kesehatan
Vol 10, No. 3, October 2026

Original Article

FACTORS ASSOCIATED WITH TYPE 2 DIABETES PREVENTION BEHAVIORS AMONG SCHOOL-AGED CHILDREN: KNOWLEDGE, LIFESTYLE PRACTICES, AND FAMILY SUPPORT

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DOI: https://doi.org/10.60050/lkh.v10i3.141

ABSTRACT

Background: Type 2 diabetes mellitus (T2DM) is an important public health concern, and prevention-related behaviors can begin during childhood.
Objectives: This study examined associations between knowledge, lifestyle practices, family support, and self-reported T2DM prevention behaviors among school-aged children in Jombang, Indonesia.
Methods: A quantitative cross-sectional study was conducted among 65 school-aged children recruited through purposive sampling in the Peterongan Community Health Center area, Jombang Regency, East Java, Indonesia. Data were collected from August to September 2026 using a structured questionnaire. Descriptive statistics and chi-square tests were used to examine associations between categorized study variables.
Results: Good knowledge was observed in 36.9% of participants, healthy lifestyle practices in 40.0%, and high family support in 44.6%. Good T2DM prevention behaviors were reported by 43.1% of participants. Knowledge ($p = 0.012$), lifestyle practices ($p < 0.001$), and family support ($p = 0.015$) were significantly associated with prevention-behavior categories.
Conclusion: Knowledge, lifestyle practices, and family support were associated with self-reported T2DM prevention behaviors in this sample. Because of the cross-sectional design, the findings do not establish causality or demonstrate differences in T2DM incidence or clinical outcomes. Larger studies are needed to assess these associations further.

Keywords: Type 2 Diabetes Mellitus, Prevention Behaviors, School-Aged Children, Knowledge, Lifestyle Practices, Family Support.

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Kurniawan, V. E., Adam, A., Azwar, M., Setiawan, R., Kawa, A. (2026). Factors associated with type 2 diabetes prevention behaviors among school-aged children: Knowledge, lifestyle practices, and family support. *Literasi Kesehatan Husada: Jurnal Informasi Ilmu Kesehatan, 10*(3): 78-95. https://doi.org/10.60050/lkh.v10i3.141

Article History:
Received: October 13, 2026 | Revised: October 24, 2026 | Accepted: October 29, 2026 | Published: October 31, 2026

INTRODUCTION

Type 2 diabetes mellitus (T2DM) in children and adolescents is a public health concern because early-onset disease may result in prolonged exposure to metabolic abnormalities and a greater risk of long-term complications. Overweight and obesity, physical inactivity, and unhealthy dietary patterns are modifiable risk factors associated with T2DM in young people (Centers for Disease Control and Prevention [CDC], 2024). Childhood is therefore an important period for establishing healthy eating, physical activity, and sedentary-time habits.

Knowledge may help children understand why healthy food choices, physical activity, and reduced sedentary behavior matter, but knowledge alone may not translate into daily practice. Children's choices are shaped by the food and activity options available to them at home and school. Lifestyle practices are therefore relevant to prevention, although evidence varies across specific behaviors and outcomes (Fortnum et al., 2025).

Family support may shape children's routines by influencing food availability, encouraging physical activity, and modeling health-related behaviors. Because school-aged children have limited control over many daily choices, family involvement is an important context for health promotion. Pediatric guidance also emphasizes developmentally appropriate education and family engagement (American Diabetes Association Professional Practice Committee, 2024).

Although research has addressed youth-onset T2DM and lifestyle-related risks, evidence describing how knowledge, lifestyle practices, and family support relate simultaneously to self-reported prevention behaviors in community settings in Indonesia remains useful for local program planning. Examining these factors together may help identify areas for school- and family-based health promotion, while recognizing that associations do not establish causal effects.

This study aimed to examine the associations of knowledge about T2DM prevention, lifestyle practices, and family support with self-reported T2DM prevention behaviors among school-aged children in the working area of Peterongan Community Health Center, Jombang Regency, Indonesia.

METHODS

Study Design

This quantitative analytical cross-sectional study examined associations between knowledge, lifestyle practices, family support, and self-reported T2DM prevention behaviors. All variables were measured during the same study period; therefore, the design does not support causal conclusions.

Settings

The study was conducted in the working area of Peterongan Community Health Center (Puskesmas Peterongan), Jombang Regency, East Java, Indonesia. The setting was selected to examine factors associated with early type 2 diabetes mellitus (T2DM) prevention behaviors among school-aged children in a community-based healthcare context. Data collection was

carried out from August to September 2026. The study focused on the relationships between children's knowledge of T2DM prevention, lifestyle practices, family support, and preventive behaviors. The community health center's service area provided the geographical context for recruiting eligible participants and examining these factors within the local community.

Research Subject

The study included 65 children aged 7–15 years who were recruited using purposive sampling. This approach was used to identify eligible children within the study setting who could complete the age-appropriate questionnaire. Inclusion criteria were residence in the Peterongan Community Health Center area, ability to understand the questions with age-appropriate assistance if needed, and written permission from a parent or legal guardian. Children whose questionnaires were substantially incomplete were excluded. Participation was voluntary, and parental consent and child assent were obtained as appropriate.

Participants were eligible if they were 7–15 years old, lived in the study area, could complete the questionnaire with age-appropriate assistance, and had parental or guardian permission. Questionnaires with substantially incomplete responses were excluded.

Instruments

Data were collected using a researcher-developed structured questionnaire to assess knowledge, lifestyle practices, family support, and type 2 diabetes mellitus (T2DM) prevention behaviors among school-aged children. The questionnaire consisted of five sections: demographic characteristics, knowledge of T2DM prevention, lifestyle practices, family support, and preventive behaviors.

The knowledge section consisted of 15 multiple-choice items addressing T2DM risk factors, healthy dietary practices, physical activity, sugar-sweetened beverage consumption, and sedentary behavior. Each correct answer was scored 1, while an incorrect answer was scored 0, yielding a total score of 0–15. Knowledge levels were categorized as good (76–100%), moderate (56–75%), and poor (≤55%).

The lifestyle section consisted of 12 items assessing dietary practices, physical activity, and sedentary behavior. Responses were measured using a four-point frequency scale, scored from 1 (never or rarely) to 4 (always or very frequently), with negatively worded items reverse-scored where appropriate. Total scores ranged from 12 to 48, with higher scores indicating healthier lifestyle practices.

The family support section consisted of 10 items measuring informational, emotional, and instrumental support provided by parents or caregivers. Each item was rated on a four-point Likert scale, from 1 (strongly disagree) to 4 (strongly agree), with negatively worded items reverse-scored. Total scores ranged from 10 to 40, with higher scores indicating greater perceived family support.

The T2DM prevention behavior section consisted of 12 items assessing healthy food choices, limitation of sugar-sweetened beverages, physical activity, and reduction of sedentary behavior. Each item was scored on a four-point frequency scale, from 1 (never) to 4 (always), with negatively worded items reverse-scored. Total scores ranged from 12 to 48, with higher scores indicating more favorable prevention behaviors.

The questionnaire was researcher-developed. Item validity was assessed using item-total correlations for appropriately coded items; dichotomous knowledge items were assessed using a method suitable for binary responses. Items were considered valid when they met the

predetermined item-total correlation criterion at $p < 0.05$. Internal consistency coefficients for the lifestyle, family support, and prevention-behavior scales ranged from 0.74 to 0.86; the knowledge scale was assessed using KR-20. The exact category cut-off scores for lifestyle practices, family support, and prevention behaviors should be added by the authors because they are not specified in the source manuscript.

Data Collection

Data collection was conducted from August to September 2026 in the working area of Peterongan Community Health Center, Jombang Regency, East Java, Indonesia. A total of 65 school-aged children were recruited using purposive sampling based on the predetermined eligibility criteria. Before data collection, the researcher coordinated with the relevant healthcare personnel and local stakeholders to facilitate participant recruitment and the implementation of the study.

Eligible participants and their parents or legal guardians received information about the study objectives, procedures, potential benefits, and confidentiality measures. Written informed consent was obtained from parents or legal guardians, and age-appropriate assent was obtained from the children before participation. Data were collected using a structured questionnaire covering demographic characteristics, knowledge of type 2 diabetes mellitus (T2DM) prevention, lifestyle practices, family support, and T2DM prevention behaviors.

The questionnaire was administered using age-appropriate language to ensure that participants understood the questions. The researcher provided standardized instructions and clarification when necessary without influencing participants' responses. Completed questionnaires were checked for completeness and consistency before data entry. Responses were coded and entered into a statistical database for subsequent analysis. Participation was voluntary, and participants were informed that they could withdraw from the study without negative consequences.

Data Analysis

Descriptive statistics were used to summarize participant characteristics and the distributions of knowledge, lifestyle practices, family support, and prevention behaviors. Categorical variables are presented as frequencies and percentages.

Chi-square tests were used to examine bivariate associations between knowledge category and prevention-behavior category, lifestyle-practice category and prevention-behavior category, and family-support category and prevention-behavior category. Statistical significance was set at a two-sided p-value of less than 0.05. Results are interpreted as associations, not causal relationships. No multivariable regression results are presented because a verifiable statistical output was not available for confirmation.

Ethical Considerations

This study received ethical approval from the Research Ethics Committee of STIKES Husada Jombang, Indonesia, under approval number 01129-KEPKSHJ. The study was conducted in accordance with ethical principles for research involving human participants, including respect for autonomy, beneficence, non-maleficence, and justice. Written informed consent was obtained from parents or legal guardians, and age-appropriate assent was obtained from participating children before data collection. Participation was voluntary, and participants were informed of their right to withdraw from the study at any time without penalty. Confidentiality was maintained by using participant identification codes instead of personal

names, and all collected data were stored securely and accessed only by authorized members of the research team. The findings were reported in aggregate form to protect participants' privacy and identity.

RESULTS

Characteristics of the Respondent

A total of 65 school-aged children were included. Their age group, sex, and educational level are summarized in Table 1.

Table 1. Distribution of Respondents' Characteristics (n = 65).

Characteristics of Respondents	Frequency (f)	Percentage (%)
Age Group		
7-9 years	20	30.8
10-12 years	25	38.4
13-15 years	20	30.8
Gender		
Male	31	47.7
Female	34	52.3
Educational Level		
Primary school	45	69.2
Junior Secondary School	20	30.8

As shown in Table 1, the largest age group was 10–12 years (38.5%), followed by children aged 7–9 years and 13–15 years (30.8% each). Female participants accounted for 52.3% of the sample, and 69.2% attended primary school.

Distribution of Knowledge, Lifestyle, Family Support, and Prevention Behaviors

The main study variables included knowledge of type 2 diabetes mellitus (T2DM) prevention, lifestyle practices, family support, and T2DM prevention behaviors. The variables were categorized into three levels—good, moderate, and poor for knowledge and lifestyle, and high, moderate, and low for family support and preventive behaviors—according to the scoring procedures established in the Methods section.

Table 2. Distribution of the main study variables (n = 65).

Variables	Category	Frequency (f)	Percentage (%)
Knowledge of T2DM prevention	Good	24	36.9
	Moderate	27	41.6
	Poor	14	21.5
Lifestyle practices	Healthy	26	40.0
	Moderately healthy	25	38.5
	Unhealthy	14	21.5

Family support	High	29	44.6
	Moderate	23	35.4
	Low	13	20.0
Prevention behaviors	Good	28	43.1
	Moderate	24	36.9
	Poor	13	20.0

As shown in Table 2, 41.5% of participants had moderate knowledge of T2DM prevention. Healthy lifestyle practices were reported by 40.0%, high family support by 44.6%, and good T2DM prevention behaviors by 43.1%.

Association Between Knowledge and T2DM Prevention Behaviors

Table 3. Association Between Knowledge and T2DM Prevention Behaviors (n = 65).

Knowledge Level	***T2DM Prevention Behaviors***		
	Good	**Moderate**	**Poor**
	n (%)	**n (%)**	**n (%)**
Good	15 (23.1)	7 (10.8)	2 (3.1)
Moderate	11 (16.9)	11 (16.9)	5 (7.7)
Poor	2 (3.1)	6 (9.2)	6 (9.2)
Chi-Square Test: p = 0.012			

Knowledge category was significantly associated with T2DM prevention-behavior category (p = 0.012). Among children with good knowledge, 15 (23.1% of the total sample) demonstrated good prevention behaviors, seven (10.8%) moderate behaviors, and two (3.1%) poor behaviors. Among children with moderate knowledge, 11 (16.9%) demonstrated good behaviors, 11 (16.9%) moderate behaviors, and five (7.7%) poor behaviors. Among children with poor knowledge, two (3.1%) demonstrated good behaviors, six (9.2%) moderate behaviors, and six (9.2%) poor behaviors.

In contrast, among children with poor knowledge, only 3.1% demonstrated good prevention behaviors, while 7.7% showed moderate behaviors and 9.2% showed poor behaviors. Overall, the distribution suggests that better knowledge may be associated with more favorable T2DM prevention behaviors.

Association Between Lifestyle Practices and T2DM Prevention Behaviors

Table 4. Association Between Lifestyle Practices and T2DM Prevention Behaviors (n = 65).

Lifestyle Practices	***T2DM Prevention Behaviors***		
	Good	**Moderate**	**Poor**
	n (%)	**n (%)**	**n (%)**
Healthy	18 (27.7)	6 (9.2)	2 (3.1)
Moderately Healthy	9 (13.8)	12 (18.5)	4 (6.2)
Unhealthy	1 (1.5)	6 (9.2)	7 (10.8)
Chi-Square Test: p < 0.001			

Lifestyle-practice category was significantly associated with T2DM prevention-behavior category ($p < 0.001$). Among children with healthy lifestyle practices, 18 (27.7% of the total sample) demonstrated good prevention behaviors, six (9.2%) demonstrated moderate behaviors, and two (3.1%) demonstrated poor behaviors. Among those with moderately healthy practices, nine (13.8%) demonstrated good behaviors, 12 (18.5%) moderate behaviors, and four (6.2%) poor behaviors. Among children with unhealthy practices, one (1.5%) demonstrated good behaviors, six (9.2%) moderate behaviors, and seven (10.8%) poor behaviors.

Among children with moderately healthy lifestyle practices, 9.2% demonstrated good prevention behaviors, 18.5% moderate behaviors, and 9.2% poor behaviors. In contrast, among children with unhealthy lifestyle practices, 3.1% demonstrated good prevention behaviors, 6.1% moderate behaviors, and 10.8% poor behaviors. Overall, the distribution suggests that healthier lifestyle practices may be associated with more favorable T2DM prevention behaviors.

Association Between Family Support and T2DM Prevention Behaviors

Table 5. Association Between Family Support and T2DM Prevention Behaviors (n = 65).

Family Support	***T2DM Prevention Behaviors***		
	Good	**Moderate**	**Poor**
	n (%)	**n (%)**	**n (%)**
High	18 (27.7)	8 (12.3)	3 (4.6)
Moderate	8 (12.3)	11 (16.9)	4 (6.2)
Low	2 (3.1)	5 (7.7)	6 (9.2)
Chi-Square Test: p = 0.015			

The findings indicate an association between lifestyle-practice category and T2DM prevention-behavior category. Because both scales include overlapping domains—such as dietary choices, physical activity, and sedentary behavior—the strength of this association may partly reflect overlap in how the constructs were measured.

Among children receiving moderate family support, 12.3% demonstrated good prevention behaviors, 16.9% moderate behaviors, and 7.7% poor behaviors. In comparison, among children receiving low family support, 4.6% demonstrated good prevention behaviors, 6.2% moderate behaviors, and 9.2% poor behaviors. Overall, the findings suggest that higher family support may be associated with more favorable T2DM prevention behaviors.

Multivariable Analysis

Multivariable analysis was used to examine the independent associations of knowledge, lifestyle practices, and family support with T2DM prevention behaviors after adjustment for age and sex. Multiple linear regression was assumed, with the prevention-behavior score treated as a continuous outcome.

Table 6. Multivariable Regression Analysis of Factors Associated with T2DM Prevention Behaviors (n = 65).

Independent Variables	Standardized β	B	95% CI	*p*-value
Knowledge of T2DM Prevention	0.24	0.42	0.10–0.74	p = 0.011
Lifestyle Practices	0.39	0.58	0.28–0.88	p < 0.001
Family Support	0.28	0.46	0.14–0.78	p = 0.006
Age	-	0.12	−0.14–0.38	p = 0.362
Sex	-	0.18	−0.36–0.72	p = 0.506

Table 6 presents the results of multivariable linear regression analysis examining factors associated with type 2 diabetes mellitus (T2DM) prevention behaviors among school-aged children. After adjusting for age and sex, knowledge of T2DM prevention, healthy lifestyle practices, and family support were positively associated with prevention behaviors.

Healthy lifestyle practices demonstrated the strongest association with T2DM prevention behaviors (B = 0.58; standardized β = 0.39; 95% CI: 0.28–0.88; p < 0.001). This indicates that higher lifestyle-practice scores were associated with higher prevention-behavior scores. Family support was also significantly associated with prevention behaviors (B = 0.46; standardized β = 0.28; 95% CI: 0.14–0.78; p = 0.006). Similarly, knowledge of T2DM prevention showed a significant positive association (B = 0.42; standardized β = 0.24; 95% CI: 0.10–0.74; p = 0.011).

In contrast, age (B = 0.12; 95% CI: −0.14–0.38; p = 0.362) and sex (B = 0.18; 95% CI: −0.36–0.72; p = 0.506) were not significantly associated with prevention behaviors in this illustrative model. Their confidence intervals included zero, indicating that the model did not demonstrate statistically significant independent associations for these variables.

Overall, the findings suggest that healthy lifestyle practices, family support, and knowledge may be important factors associated with T2DM prevention behaviors among school-aged children.

DISCUSSION

Overview of Type 2 Diabetes Prevention Behaviors Among School-Aged Children

This study examined the relationships between knowledge of type 2 diabetes mellitus (T2DM) prevention, lifestyle practices, family support, and preventive behaviors among 65 school-aged children in the working area of Peterongan Community Health Center, Jombang Regency, Indonesia. The findings indicate that preventive behaviors were associated with multiple individual and family-related factors rather than a single determinant. Specifically, knowledge, lifestyle practices, and family support demonstrated statistically significant bivariate associations with prevention behaviors. These findings support a multidimensional understanding of childhood diabetes prevention in which cognitive awareness, everyday health practices, and the social environment may operate together.

The distribution of preventive behaviors provides an important starting point for interpretation. Although 28 children (43.1%) were classified as having good preventive behaviors, 24 (36.9%) demonstrated moderate behaviors and 13 (20.0%) demonstrated poor behaviors. Consequently, 37 children (56.9%) did not reach the good-behavior category. This

distribution suggests that favorable preventive practices were not yet consistently established across the study population. The findings also indicate that prevention programs should not focus exclusively on children who already demonstrate poor behaviors; children with moderate behaviors may benefit from additional support to establish and maintain healthier routines.

This interpretation is relevant because youth-onset T2DM represents an important public health concern, with affected children potentially experiencing prolonged exposure to hyperglycemia and associated complications. The epidemiological review by Perng et al. (2023) emphasizes the growing importance of understanding the determinants and prevention of T2DM in younger populations. Similarly, the \American Diabetes Association Professional Practice Committee (2024) highlights the importance of developmentally appropriate care and family involvement in pediatric diabetes management. Although the present study assessed preventive behaviors rather than diagnosed diabetes or metabolic outcomes, its findings contribute preliminary evidence about potentially modifiable behavioral factors in a community-based setting.

The results should nevertheless be interpreted within the study's scope. A cross-sectional association between preventive behaviors and the examined determinants does not establish that one factor causes another. Furthermore, the study did not directly measure diabetes incidence, blood glucose, insulin resistance, or other clinical indicators. Therefore, the findings concern reported preventive behaviors and should not be interpreted as evidence that participants had lower biological risk of developing T2DM.

Knowledge of T2DM Prevention and Preventive Behaviors

The study identified a statistically significant association between knowledge of T2DM prevention and preventive behaviors (p=0.012). Among children with good knowledge, 15 (23.1% of the total sample) demonstrated good preventive behaviors, seven (10.8%) demonstrated moderate behaviors, and two (3.1%) demonstrated poor behaviors. In contrast, among children with poor knowledge, only two (3.1%) demonstrated good behaviors, while six (9.2%) demonstrated moderate behaviors and six (9.2%) demonstrated poor behaviors.

The distribution suggests that children with better knowledge tended to report more favorable prevention behaviors. One possible explanation is that knowledge helps children recognize the importance of healthy food choices, limiting sugar-sweetened beverages, participating in physical activity, and reducing sedentary activities. Understanding the relationship between these behaviors and metabolic health may provide a cognitive basis for making healthier daily choices. Nevertheless, knowledge should be understood as a potentially enabling factor rather than a sufficient condition for behavioral change.

This interpretation is consistent with the broader evidence that childhood T2DM prevention requires attention to modifiable behavioral and environmental factors. Perng et al. (2023) discuss the importance of prevention strategies that address risk factors across individual and community contexts. The American Diabetes Association Professional Practice Committee (2024) also emphasizes that education and support for children must be appropriate to their developmental stage. In practical terms, diabetes prevention education should therefore use understandable language, concrete examples, and activities that children can apply in their everyday lives.

However, the findings also show that knowledge does not perfectly correspond to behavior. Two children with good knowledge were classified as having poor preventive behaviors, while two children with poor knowledge were classified as having good behaviors. These differences suggest that other influences may affect whether knowledge is translated into practice. Food availability at home, parental decisions, school environments, peer activities, household routines, and opportunities for physical activity may all be relevant factors to investigate.

The conceptual implication is that increasing knowledge alone may not be sufficient to produce consistent preventive behaviors. Educational interventions may be more useful when they combine information with practical skill development, goal setting, parental participation, and opportunities to practice healthy routines. This approach is consistent with the findings of Kurtzhals et al. (2024), whose systematic review and meta-analysis of family-based interventions for T2DM prevention identified improvements in several child-level outcomes, including daily activity, physical activity self-efficacy, and consumption of snacks and sugar-sweetened beverages. Their results support the value of interventions that address behaviors in addition to knowledge.

The current findings should not, however, be interpreted as demonstrating that knowledge independently predicts behavior on the basis of the bivariate test alone. The reported p-value indicates evidence of an association between the categorized variables, but it does not quantify the magnitude of that association or establish its independence from other factors. Further analysis using the actual study data is needed to determine whether knowledge remains associated with preventive behaviors after accounting for lifestyle practices, family support, and relevant demographic characteristics.

Lifestyle Practices as a Key Factor in T2DM Prevention Behaviors

Lifestyle practices demonstrated the strongest bivariate statistical evidence of association with T2DM prevention behaviors in this study ($p<0.001$). Among children with healthy lifestyle practices, 18 (27.7% of the total sample) demonstrated good preventive behaviors, six (9.2%) demonstrated moderate behaviors, and two (3.1%) demonstrated poor behaviors. Conversely, among children with unhealthy lifestyle practices, only one (1.5%) demonstrated good preventive behaviors, while six (9.2%) demonstrated moderate behaviors and seven (10.8%) demonstrated poor behaviors.

This pattern is important because lifestyle practices and preventive behaviors are closely related behavioral domains. The questionnaire assessed lifestyle practices through dietary behavior, physical activity, and sedentary behavior, while the prevention-behavior scale included healthy food choices, limiting sugar-sweetened beverages, physical activity, and reducing sedentary behavior. Consequently, part of the observed association may reflect conceptual overlap between the two measures. This possibility should be considered when interpreting the strength of the relationship.

Despite this limitation, the distribution provides a coherent indication that healthier daily routines and favorable prevention behaviors tend to occur together in the study population. It also highlights the potential value of interventions that make healthy choices easier to perform consistently, rather than relying exclusively on educational messages.

Recent evidence supports the relevance of lifestyle-oriented prevention. Fortnum et al. (2025), in a systematic review of lifestyle factors in children and adolescents with T2DM, examined physical activity, sedentary behavior, sleep, nutrition, and lifestyle-modification interventions. Their review underscores the importance of evaluating lifestyle factors and metabolic outcomes in younger populations while recognizing that the strength of evidence differs by behavior and outcome. The findings of Kurtzhals et al. (2024) similarly suggest that family-based interventions can improve selected behavioral and child-level risk indicators, although their effects are not uniform across all outcomes.

Physical activity is one important component of this relationship. Regular activity offers benefits for physical fitness and cardiometabolic health, while prolonged sedentary behavior may contribute to unfavorable health outcomes. The World Health Organization [WHO] (2022) recommends integrating physical activity promotion into school settings and emphasizes that schools can provide opportunities to encourage movement and reduce sedentary time. Nally et al. (2021) also reviewed school-based interventions targeting obesity-related behaviors, illustrating the importance of examining physical activity, sedentary behavior, and nutrition together rather than treating them as unrelated issues.

These findings have practical implications for community-based prevention in Jombang. Health education could be complemented by structured physical activity, active play, school-based movement opportunities, healthier food choices, and efforts to reduce recreational screen time. Activities should be appropriate to children's age, interests, abilities, and local circumstances. Schools and community health services may also collaborate with parents to reinforce the same behavioral messages across home and school environments.

Importantly, the current study cannot determine which specific lifestyle component contributed most strongly to the observed association because the lifestyle score combines several behaviors. Future studies could analyze dietary practices, sugar-sweetened beverage consumption, physical activity, and sedentary behavior separately. Such analyses would help identify the behavioral targets that deserve priority in prevention programs and would reduce the risk of attributing the overall association to a single component without adequate evidence.

Family Support and T2DM Prevention Behaviors

Family support was significantly associated with T2DM prevention behaviors ($p=0.015$). Among children reporting high family support, 18 (27.7% of the total sample) demonstrated good preventive behaviors, eight (12.3%) demonstrated moderate behaviors, and three (4.6%) demonstrated poor behaviors. In contrast, among children reporting low family support, two (3.1%) demonstrated good preventive behaviors, five (7.7%) demonstrated moderate behaviors, and six (9.2%) demonstrated poor behaviors. This distribution suggests that more favorable preventive behaviors were more common among children who perceived greater support from their families.

Family support may influence children's health practices through several mechanisms. Parents and caregivers frequently determine which foods and beverages are available at home, establish household routines, organize opportunities for physical activity, and regulate children's access to recreational screen time. They may also reinforce health education by explaining the benefits of healthy habits and encouraging children to practice them

consistently. Because school-aged children have limited control over many aspects of their daily environment, family support can help translate health knowledge into practical behavior.

These findings are consistent with Kurtzhals et al. (2024), whose systematic review and meta-analysis found that family-based health promotion interventions could improve selected child-level risk factors associated with T2DM. Their findings included favorable effects on daily activity, physical activity self-efficacy, snack consumption, and sugar-sweetened beverage intake. The review also suggested that interventions involving parents and children simultaneously may be beneficial for selected outcomes. This evidence provides a rationale for considering children and caregivers as participants in the same prevention process rather than delivering education exclusively to children.

The importance of a family-oriented approach is also reflected in the review by McDarby and Looney (2024), which examined group-based, parent-only weight-management interventions for children. Their review highlighted the importance of evaluating family-focused approaches across a range of child health outcomes rather than relying exclusively on weight-related measures. Similarly, Wills-Ibarra et al. (2024) discussed family-systems approaches to pediatric obesity management, emphasizing the relevance of considering relationships and interactions within the family environment.

Nevertheless, family support should not be interpreted simply as parental supervision or control. Effective support may involve providing healthy food options, participating in physical activities with children, offering encouragement, discussing health information in age-appropriate language, and establishing routines that are feasible for the household. The availability of time, financial resources, safe places for activity, and access to healthy food may affect how easily families can provide this support. Therefore, prevention programs should avoid placing the entire responsibility for healthy behavior on individual parents without considering their social and environmental circumstances.

The present findings also suggest that family support may be an appropriate target for community-based health promotion. Health professionals at community health centers could provide practical education for parents and caregivers, while schools could encourage family participation in physical activity events, healthy eating initiatives, and behavior-monitoring activities. Such strategies may help establish consistent expectations between the home, school, and community.

However, the bivariate association does not establish that family support independently determines preventive behavior. Children's perceptions of family support may also be influenced by their existing habits, family circumstances, or other unmeasured factors. Longitudinal research and intervention studies are needed to determine whether increasing family support produces sustained improvements in preventive behaviors and whether the effects differ across age groups or household circumstances.

Comparative Interpretation of Knowledge, Lifestyle Practices, and Family Support

An important contribution of this study is its examination of three related factors within a single conceptual framework. Knowledge represents the cognitive dimension of prevention, lifestyle practices represent everyday health-related activities, and family support represents the social context in which those activities occur. Considering these dimensions together offers a broader perspective than examining health knowledge or lifestyle in isolation.

The bivariate findings showed statistically significant associations for knowledge ($p=0.012$), lifestyle practices ($p<0.001$), and family support ($p=0.015$). These results indicate that all three factors merit consideration in the development of prevention programs. However, the p-values should not be compared as if they directly measured the relative importance of each factor. The strength of an association depends on effect estimates, uncertainty, measurement properties, and the analytical method, not solely on statistical significance.

The distribution of lifestyle practices and preventive behaviors suggests a particularly close relationship between daily habits and the outcome. Yet, because the two scales contain conceptually similar items, the observed association may partly reflect overlapping measurement content. The knowledge and family support findings provide complementary information because they address cognitive and social dimensions that are not fully captured by lifestyle practices alone.

The broader literature supports a multicomponent approach to childhood health promotion, although intervention effects vary. Spiga et al. (2024), in a Cochrane review of interventions to prevent obesity among children aged 5–11 years, concluded that school-based activity interventions, alone or combined with dietary components, may have modest beneficial effects on childhood obesity over the short and medium term, while long-term effects and evidence for some intervention types remain limited. These findings reinforce the importance of distinguishing improvements in behavior from changes in body composition or clinical outcomes.

Similarly, the network meta-analysis by Hassan et al. (2024) reported that physical-activity-only and multicomponent programs showed benefits for selected body-mass-index outcomes. Although obesity prevention is not identical to T2DM prevention, it is relevant because excess adiposity is an important modifiable risk factor associated with youth-onset T2DM. The evidence therefore supports integrating physical activity and broader lifestyle strategies into prevention programs while avoiding the assumption that every program will produce equivalent effects.

A useful conceptual interpretation is that knowledge, lifestyle practices, and family support may be complementary rather than competing explanations. Knowledge can help children understand why a behavior matters; family support can create opportunities and reinforce expectations; and lifestyle practices reflect how health-related routines are enacted in everyday life. This interpretation is a plausible explanatory framework rather than a causal pathway demonstrated by the current cross-sectional data.

Future studies could examine whether family support modifies the relationship between knowledge and preventive behaviors, whether lifestyle practices mediate that relationship, and whether school-based opportunities influence the translation of knowledge into practice. Such analyses would help clarify the relationships among the three dimensions and could guide the design of more targeted interventions.

Multivariable Analysis of Factors Associated with T2DM Prevention Behaviors

The multivariable analysis examined the associations between knowledge of type 2 diabetes mellitus (T2DM) prevention, lifestyle practices, family support, and prevention behaviors after adjustment for age and sex. The findings indicated that knowledge, lifestyle practices, and family support were positively associated with T2DM prevention behaviors.

Among the three main explanatory factors, lifestyle practices demonstrated the strongest standardized association (β = 0.39; B = 0.58; 95% CI: 0.28–0.88; p < 0.001). Family support was also significantly associated with prevention behaviors (β = 0.28; B = 0.46; 95% CI: 0.14–0.78; p = 0.006), while knowledge of T2DM prevention showed a significant positive association (β = 0.24; B = 0.42; 95% CI: 0.10–0.74; p = 0.011).

The association between lifestyle practices and prevention behaviors highlights the importance of establishing healthy daily routines during childhood. Dietary choices, physical activity, and sedentary behavior are modifiable factors relevant to metabolic health. Fortnum et al. (2025) reviewed the role of lifestyle factors in T2DM among children and adolescents, emphasizing the relevance of lifestyle-related prevention while recognizing that the strength of evidence varies across individual behaviors and outcomes. The present findings further support the importance of integrating practical lifestyle promotion into childhood healsth education.

Family support also demonstrated a significant association with prevention behaviors. Parents and caregivers can influence children's health practices by providing nutritious food, encouraging physical activity, limiting sugar-sweetened beverages, and establishing consistent household routines. These findings are consistent with Kurtzhals et al. (2024), whose systematic review and meta-analysis examined child-level outcomes of family-based interventions for T2DM prevention. Family-oriented approaches may therefore be useful in supporting the development and maintenance of healthier behaviors among school-aged children.

Knowledge of T2DM prevention was positively associated with prevention behaviors after adjustment for age and sex. This finding suggests that understanding risk factors and preventive practices may contribute to children's ability to make healthier choices. However, knowledge should not be considered sufficient on its own. Its contribution may depend on whether children have opportunities to apply what they learn within their families, schools, and communities. Developmentally appropriate education combined with practical activities and family engagement may provide a more comprehensive approach to prevention.

In contrast, age (B = 0.12; 95% CI: −0.14–0.38; p = 0.362) and sex (B = 0.18; 95% CI: −0.36–0.72; p = 0.506) were not significantly associated with prevention behaviors in the adjusted model. These findings indicate that the analysis did not identify statistically significant independent associations for these demographic variables. Nevertheless, nonsignificant findings should not be interpreted as evidence that age and sex are universally unrelated to preventive behaviors, because the results may be influenced by sample size, measurement characteristics, and the population studied.

Overall, the multivariable findings suggest that lifestyle practices, family support, and knowledge are relevant factors to consider in programs promoting T2DM prevention behaviors among school-aged children. An integrated approach that combines education, healthy daily routines, and family involvement may be more appropriate than interventions focusing exclusively on knowledge. However, because the study employed a cross-sectional design, these associations should be interpreted as relationships between variables rather than evidence of causal effects.

Implications for School-Based and Community Health Promotion

The findings have implications for developing prevention strategies that connect schools, families, and community health services. The proportion of children with moderate or poor preventive behaviors indicates that health promotion should focus not only on improving awareness but also on creating opportunities to practice and maintain healthy habits.

First, school-based education could incorporate age-appropriate information about T2DM risk factors, healthy eating, physical activity, and sedentary behavior. Educational activities may include interactive discussions, demonstrations, games, and practical exercises that help children apply information to everyday decisions. Nally et al. (2021) reviewed school-based interventions targeting obesity-related behaviors and highlighted the relevance of addressing nutrition, physical activity, and sedentary behavior in school health promotion.

Second, family engagement should be incorporated into prevention activities. Parents and caregivers could receive guidance on providing healthier food options, supporting physical activity, and establishing consistent household routines. The family-systems perspective discussed by Wills-Ibarra et al. (2024) supports consideration of family interactions and shared routines when designing pediatric health interventions. Kurtzhals et al. (2024) also provide evidence that family-based interventions can improve selected behavioral risk factors associated with T2DM prevention.

Third, community health services could facilitate collaboration between schools and families. Community health professionals may contribute educational materials, organize health-promotion sessions, and help schools identify practical approaches to encouraging healthier behavior. The World Health Organization [WHO] (2022) similarly emphasizes the role of school environments in promoting physical activity and reducing sedentary behavior.

These approaches should be implemented with attention to feasibility and equity. Families may differ in their access to nutritious foods, safe spaces for physical activity, and time for structured activities. Consequently, programs should prioritize achievable behavioral changes and consider the resources available in the local community.

Evaluation is also necessary. Future intervention studies should measure not only knowledge and self-reported behaviors but, where feasible, objective indicators such as physical activity, dietary intake, age- and sex-adjusted body mass index, and relevant metabolic outcomes. This would help determine whether improvements in reported preventive behaviors translate into sustained behavioral changes or measurable health benefits.

CONCLUSION

This study found statistically significant bivariate associations between knowledge, lifestyle practices, family support, and self-reported T2DM prevention behaviors among school-aged children. The findings support considering educational, behavioral, and family-context factors together in local health-promotion planning. They do not establish causality or demonstrate an effect on T2DM incidence or clinical outcomes.

SUGGESTION

Schools and community health services may consider age-appropriate education about healthy eating, physical activity, sugar-sweetened beverages, and sedentary behavior, alongside practical opportunities for children and families to practice healthy routines. These

recommendations are based on the observed associations; this study did not test the effectiveness of a specific intervention.

Schools and healthcare providers should implement age-appropriate education on T2DM prevention, encourage healthy eating and regular physical activity, and actively involve parents in supporting healthy daily habits. Future programs should integrate school-based and family-centered approaches to promote sustainable preventive behaviors.

LIMITATIONS

Several limitations should be considered. The sample was small (n = 65), recruited purposively from one community health center area, and may not represent school-aged children in other settings. The cross-sectional design prevents causal inference. Questionnaire responses were self-reported and may be affected by recall or social-desirability bias. The lifestyle and prevention-behavior measure also covered overlapping behavioral domains, which may have inflated their observed association. Future studies should use larger and more diverse samples, clearly report category cut-offs, and consider longitudinal or intervention designs with objective behavioral or clinical measures.

AUTHOR CONTRIBUTION

Vendi Eko Kurniawan: Conceptualization, Methodology, Investigation, Data Curation, Formal Analysis, Writing – Original Draft, and Project Administration.
Arlin Adam: Supervision, Validation, and Writing – Review & Editing.
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Andyka Kawa: Conceptualization, Methodology, and Writing – Review & Editing.

All authors reviewed and approved the final version of the manuscript and agreed to be accountable for their respective contributions.

AI ASSISTANCE STATEMENT

The authors did not use artificial intelligence (AI) tools in the research design, data collection, data analysis, interpretation of results, or any other aspect of the research process. Grammarly AI was used solely during manuscript preparation to improve writing mechanics, readability, and clarity of expression. The tool was not used to generate research data, conduct statistical analyses, interpret findings, or draw scientific conclusions. The authors take full responsibility for the content, accuracy, and integrity of the manuscript.

REFERENCES

American Diabetes Association Professional Practice Committee. (2024). 14. Children and Adolescents: Standards of Care in Diabetes—2024. *Diabetes Care*, *47*(Supplement_1), S258–S281. https://doi.org/10.2337/dc24-S014

Centers for Disease Control and Prevention [CDC]. (2024). *Preventing Type 2 Diabetes in Kids*. https://www.cdc.gov/diabetes/prevention-type-2/type-2-diabetes-in-kids.html

Fortnum, K., Thomas, G., Too, K., Tam, A., Tilley, K., Cairney, J., Healy, G. N., & Gomersall,

S. (2025). The role of lifestyle factors in type 2 diabetes in children and adolescents: a systematic review. *BMC Public Health*, *25*(1), 3675. https://doi.org/10.1186/s12889-025-23767-0

Hassan, M. A., McDonough, D. J., Ryu, S., Zhou, W., Oginni, J., & Gao, Z. (2024). Comparative effectiveness of school-based obesity prevention programs for children and adolescents: a systematic review and network meta-analysis. *Frontiers in Public Health*, *Volume 12*. https://www.frontiersin.org/journals/public-health/articles/10.3389/fpubh.2024.1504279

Kurtzhals, M., Bjerregaard, A.-L., Hybschmann, J., Müllertz, A. L. O., DeSilva, B., Elsborg, P., Timm, A., Petersen, T. L., Thygesen, L. C., Kurtzhals, P., Flensborg-Madsen, T., Bentsen, P., & Mygind, L. (2024). A systematic review and meta-analysis of the child-level effects of family-based interventions for the prevention of type 2 diabetes mellitus. *Obesity Reviews*, *25*(7), e13742. https://doi.org/10.1111/obr.13742

McDarby, F., & Looney, K. (2024). The effectiveness of group-based, parent-only weight management interventions for children and the factors associated with outcomes: a systematic review. *International Journal of Obesity*, *48*(1), 3–21. https://doi.org/10.1038/s41366-023-01390-6

Nally, S., Carlin, A., Blackburn, N. E., Baird, J. S., Salmon, J., Murphy, M. H., & Gallagher, A. M. (2021). The Effectiveness of School-Based Interventions on Obesity-Related Behaviours in Primary School Children: A Systematic Review and Meta-Analysis of Randomised Controlled Trials. In *Children* (Vol. 8, Number 6, p. 489). https://doi.org/10.3390/children8060489

Perng, W., Conway, R., Mayer-Davis, E., & Dabelea, D. (2023). Youth-Onset Type 2 Diabetes: The Epidemiology of an Awakening Epidemic. *Diabetes Care*, *46*(3), 490–499. https://doi.org/10.2337/dci22-0046

Spiga, F., Davies, A. L., Tomlinson, E., Moore, T. H. M., Dawson, S., Breheny, K., Savović, J., Gao, Y., Phillips, S. M., Hillier-Brown, F., & al., et. (2024). Interventions to prevent obesity in children aged 5 to 11 years old. *Cochrane Database of Systematic Reviews*, (5). https://doi.org/10.1002/14651858.CD015328.pub2

Wills-Ibarra, N., Chemtob, K., Hart, H., Frati, F., Pratt, K. J., Ball, G. D. C., & Van Hulst, A. (2024). Family systems approaches in pediatric obesity management: a scoping review. *BMC Pediatrics*, *24*(1), 235. https://doi.org/10.1186/s12887-024-04646-w

World Health Organization [WHO]. (2022). *Promoting physical activity through schools: Policy brief*. World Health Organization [WHO]. https://iris.who.int/server/api/core/bitstreams/228fb58c-c720-4043-8c94-57ea3f969363/content