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Educational Strategies for Prevention of Type 2 Diabetes Mellitus among Secondary School Students in Indonesia: Mini Review

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ABSTRACT

This mini-review aimed to identify, classify, and synthesize educational strategies for preventing T2DM among secondary school students in Indonesia and examine their effects on knowledge, attitudes, and behaviors. A structured literature search was conducted for journal articles published between January 2025 and June 2026 using Indonesian and English terms related to T2DM, prevention, education, adolescents, and secondary schools. These findings analyze 16 primary studies that met the criteria. Study characteristics, intervention formats, designs, and outcomes were extracted and narratively synthesized. The interventions comprised interactive infographics, educational videos, audiovisual materials, animated multimedia, booklets, leaflets, digital book-based discussions, and educational games. Most studies employed one-group pretest-posttest designs and reported significant improvements in knowledge. Positive changes in attitudes and preventive behaviors were also reported, particularly following interactive or repeated interventions; however, these outcomes were assessed less frequently. Heterogeneity in study designs, instruments, intervention duration, and follow-up prevented direct comparisons among strategies. Overall, these interventions appear promising for improving T2DM prevention knowledge among Indonesian students. School-based programs should combine age-appropriate media with interactive learning, nutrition literacy, physical activity, healthy school policies, parental engagement, and health-service collaboration. Controlled studies using standardized measures and longer follow-up periods are required to determine sustained behavioral effects.

INTRODUCTION

Type 2 diabetes mellitus (T2DM) has become a major public health problem whose burden continues to increase across countries. An analysis from the *IDF Diabetes Atlas* estimated that approximately 537 million adults were living with diabetes in 2021, and this number is projected to reach approximately 783 million by 2045 (Sun et al., 2022). In Indonesia, a serial analysis of national health surveys showed that the prevalence of diabetes among individuals aged ≥15 years changed from 10.7% in 2013 to 11.8% in 2018 and 11.3% in 2023, indicating that the national burden remained high and generally increased over the decade despite some fluctuations (Muharram et al., 2025); (Suci et al., 2025). This problem is no longer confined to adults, as the age-standardized prevalence of T2DM among young people increased markedly between 1990 and 2021, with a high body mass index identified as one of its major risk factors (Chen et al., 2025). These findings indicate that the processes underlying T2DM risk begin during adolescence, emphasizing the need to initiate prevention before the disease develops in adulthood.

Indonesian secondary school students are particularly vulnerable to developing T2DM risk factors because of changes in their dietary patterns and daily activities. The increasing availability of processed foods and sugar-sweetened beverages may encourage excessive sugar and energy intake, while the consumption of fruits, vegetables, and fiber-rich foods remains suboptimal (Sartika et al., 2022). At the same time, insufficient physical activity, sedentary behavior, and the increasing use of smartphones and other screen-based devices may reduce the time adolescents spend engaging in active movement. It has been estimated that approximately 57% of Indonesian children do not engage in sufficient physical activity, while electronic device use and prolonged screen time are among the factors contributing to sedentary behavior (Hanifah et al., 2023). The combination of high sugar intake, physical inactivity, and sedentary behavior may increase the risk of overweight and obesity, which play an important role in the development of insulin resistance. Adolescence is also a critical period for habit formation because health behaviors established during this stage may persist into adulthood (Prihanto et al., 2021).

Schools provide a strategic setting for T2DM prevention because they can reach students in a structured, extensive, and sustained manner. Health education can be integrated into classroom learning, physical activity programs, management of the school food environment, counseling services, and other health-promotion activities. Schools also provide a social environment in which health messages can be delivered repeatedly, allowing students to reinforce their knowledge and apply it in their daily lives (Pulimeno et al., 2020). In Indonesia, the School Health Unit (*Usaha Kesehatan Sekolah*; UKS) can serve as a platform for integrating health education, health services, and the development of a school environment that supports healthy behaviors (Prihanto et al., 2021). Its implementation requires teachers to serve as learning facilitators, health professionals to provide accurate information and guidance, and peers to act as communicators who are closely connected to students' everyday experiences. Peer-led approaches may increase message acceptance through shared experiences, relatability, and trust, although peer educators still require appropriate training and support from teachers and health professionals (Dodd et al., 2022); (Widnall et al., 2024).

Educational strategies for preventing T2DM among adolescents have developed from conventional health counseling toward more varied and interactive approaches. These strategies may incorporate videos, multimedia, infographics, e-learning, digital books, booklets, leaflets, flyers, educational games, group discussions, and peer education. The planned integration of text, audio, images, animation, and interactive activities can help students understand complex information; however, its effectiveness remains influenced by the suitability of the content, language level, duration, and learner

characteristics (Çeken & Taşkın, 2022). Several Indonesian studies have reported that interactive infographics can improve students' knowledge of diabetes (Deshinta Adelia Arisna Putri & Yudanari, 2025), while booklet-based education may influence adolescents' knowledge and attitudes toward diabetes prevention (Hamid et al., 2025). Multimedia education using animated videos has also demonstrated the potential to improve secondary school students' knowledge, attitudes, and diabetes-prevention behaviors (Suryati et al., 2025). Therefore, engaging educational media that are appropriate for adolescent characteristics may increase student participation, particularly when accompanied by discussion, feedback, and support from the school environment.

Although research on diabetes-prevention education among Indonesian adolescents has begun to expand, the available evidence remains highly heterogeneous. Previous studies have employed different designs, including one-group pretest–posttest and quasi-experimental designs with control groups, as well as different educational media, intervention durations, measurement instruments, and assessment periods (Deshinta Adelia Arisna Putri & Yudanari, 2025); (Hamid et al., 2025); (Suryati et al., 2025). Most studies have focused primarily on knowledge outcomes, whereas changes in attitudes, actual behaviors, and the sustainability of educational effects have not been consistently evaluated. A similar pattern was identified in a systematic review of school-based peer health education, in which improvements in health-related knowledge were reported more frequently than positive behavioral changes (Dodd et al., 2022). Based on the preliminary search conducted for the present review, no synthesis has specifically mapped recent primary studies published between January 2025 and June 2026 involving secondary school students in Indonesia. A mini review is therefore needed to provide a structured overview of the educational strategies that have been implemented and the outcomes they have produced.

This mini review purpose to identify, categorize, and synthesize educational strategies used to prevent T2DM among secondary school students in Indonesia based on primary studies published between January 2025 and June 2026. The synthesis focuses on mapping the types of educational media, delivery methods, intervention duration, education providers, research designs, measurement instruments, and intervention effects on students' knowledge, attitudes, and preventive behaviors. The findings are expected to assist schools, teachers, health professionals, and UKS administrators in selecting educational strategies that are relevant, engaging, and feasible within the resources available in each school. Furthermore, this review may provide a foundation for future researchers to develop more standardized interventions, employ valid measurement instruments, include appropriate comparison groups, and conduct longer-term evaluations of behavioral outcomes.

METHOD

Review Design and Research Question

This study employed a structured mini-review design with a narrative synthesis approach to identify, summarize, and compare recent evidence on educational strategies for preventing type 2 diabetes mellitus among secondary school students in Indonesia. This design was selected because it allowed the review to examine educational interventions that varied in their delivery methods, educational media, duration, study designs, and outcome measures. The review process emphasized a clearly defined objective, transparent literature-search procedures, appropriate referencing, scientific reasoning, and balanced evidence presentation.

The review focused on students enrolled in Indonesian junior and senior secondary schools, including junior high schools (*Sekolah Menengah Pertama* [SMP]),

Islamic junior high schools (*Madrasah Tsanawiyah* [MTs]), senior high schools (*Sekolah Menengah Atas* [SMA]), Islamic senior high schools (*Madrasah Aliyah* [MA]), and vocational high schools (*Sekolah Menengah Kejuruan* [SMK]). Educational strategies were defined as educational or health-promotion activities explicitly addressing type 2 diabetes mellitus, its risk factors, or preventive measures. These strategies could include face-to-face education, printed materials, audiovisual media, educational games, digital platforms, e-learning, or multicomponent approaches. The primary review question was: "What educational strategies have been implemented to support type 2 diabetes mellitus prevention among secondary school students in Indonesia, how were these strategies delivered, and what outcomes were reported regarding students' knowledge, attitudes, and preventive behaviors?"

Information Sources and Search Strategy

Literature searches were conducted using GARUDA, Google Scholar, PubMed, and the Directory of Open Access Journals (DOAJ). These sources were selected to identify publications from both national and international journals that involved secondary school students in Indonesia. The publication period was restricted to January 1, 2025, through June 30, 2026. Eligibility based on publication date was determined using the official publication date or, where applicable, the first online publication date displayed on the journal website rather than the period in which the study was conducted. The final literature search was conducted on [July 15, 2026]. No restrictions were imposed regarding the country in which the journal was published; however, eligible articles had to be available as full texts in either Indonesian or English.

The search strategy combined Indonesian and English keywords and was adapted to the search functions of each information source. Indonesian search terms included "diabetes melitus tipe 2," "diabetes mellitus tipe 2," "pencegahan diabetes," "edukasi kesehatan," "pendidikan kesehatan," "promosi kesehatan," "penyuluhan," "media edukasi," "siswa," "remaja," "SMP," "MTs," "SMA," "MA," and "SMK." English search terms included "type 2 diabetes mellitus," "diabetes prevention," "health education," "educational intervention," "health promotion," "educational media," "adolescent," "student," "junior high school," "senior high school," "secondary school," and "Indonesia." The terms were combined using the Boolean operators AND and OR to broaden or refine the search results.

Additional searches were performed by examining the reference lists of potentially relevant articles to identify publications that might not have been retrieved through the database searches. Each identified record was documented in a search worksheet containing the title, authors, year of publication, journal name, digital object identifier or article link, and information source. Records retrieved from more than one source were identified and removed before screening. The publication date and status of each potentially eligible article were also verified through the official journal website to ensure compliance with the predefined publication period.

Eligibility Criteria and Article Selection

Articles were eligible for inclusion if they were published in national or international peer-reviewed journals between January 1, 2025, and June 30, 2026; reported a study conducted in Indonesia; involved students enrolled in SMP/MTs, SMA/MA, or SMK; and evaluated an educational strategy explicitly related to type 2 diabetes mellitus or its prevention. Eligible articles were also required to report at least one measurable outcome, including knowledge, awareness, attitudes, behavioral intentions, self-efficacy, dietary behavior, sugar-sweetened beverage consumption, physical activity, preventive behavior, or diabetes-related risk indicators. Studies

involving mixed populations were considered eligible only when findings for Indonesian secondary school students could be extracted separately.

Eligible publication types included original research articles using experimental, quasi-experimental, pre-experimental, evaluative observational, or mixed-methods designs. Peer-reviewed evaluations of community-engagement or school-based education programs were also considered when they adequately described the participants, educational intervention, measurement procedures, and intervention outcomes. Articles were excluded if they examined only the prevalence or risk factors of diabetes without implementing an educational intervention; focused on the treatment or management of individuals already diagnosed with diabetes; exclusively addressed type 1 diabetes; or involved primary school students, university students, the general population, or adults without separately reporting data for secondary school students. Review articles, editorials, letters to the editor, research protocols, undergraduate theses, master's theses, dissertations, books, conference proceedings, conference abstracts, duplicate publications, and articles without accessible full texts were also excluded.

Article selection was conducted in two stages. The first stage involved screening titles and abstracts to remove clearly irrelevant publications. Articles considered potentially eligible were subsequently assessed through full-text examination. Two reviewers independently conducted the selection process using the predefined eligibility criteria. Any disagreement between the reviewers was resolved through discussion and consensus. Reasons for excluding articles during the full-text assessment were documented to maintain transparency in the study-selection process.

Data Extraction and Narrative Synthesis

Data from each eligible article were extracted using a standardized data-extraction form. The extracted information included the authors, publication year, study location, school level, participant characteristics and sample size, study design, sampling technique, type of educational strategy or medium, intervention provider, educational content, intervention duration and frequency, comparator group when available, measurement instrument, timing of outcome assessment, primary findings, and study limitations. Data were extracted by one reviewer and independently verified by a second reviewer to reduce recording errors and ensure consistency with the original publication. Any discrepancies were resolved by re-examining the full-text article and reaching consensus.

The findings were synthesized narratively because variations in study designs, participant characteristics, educational media, intervention duration, measurement instruments, and outcome reporting were expected to preclude meaningful statistical pooling through meta-analysis. The included articles were grouped according to educational strategy, including face-to-face education, printed materials, video or audiovisual media, educational games and gamification, digital platforms or e-learning, and multicomponent interventions. The synthesis compared intervention characteristics, directions of outcome changes, consistency of findings, methodological strengths, and study limitations. Interpretations of effectiveness primarily focused on changes in knowledge, attitudes, and diabetes-prevention-related behaviors. Improvements in these outcomes were not interpreted as direct reductions in the incidence of type 2 diabetes mellitus unless the studies reported relevant clinical indicators or included adequate long-term follow-up.

RESULTS

Table 1 summarizes the characteristics and principal findings of the 16 primary studies selected for this mini review. The studies were published between January 2025 and June 2026 and involved junior and senior secondary school students from different regions of Indonesia. The interventions included audiovisual, printed, digital, game-based, peer-led, and discussion-based educational strategies. The table presents the study setting, participant characteristics, research design, educational strategy, measured outcomes, and principal findings.

Table 1. Analysis of the research findings

Title (author and year)	Setting and participants	Study design	Educational strategy	Main findings
The Effect of Health Education as a Preventive Effort Against Diabetes Mellitus in Adolescents at SMA Negeri 4 Kota Parepare (Rosyida et al., 2025)	SMA Negeri 4 Parepare; n=29	One-group pretest–posttest	A 60-minute session using audiovisual media, leaflets, and interactive discussion	Mean knowledge increased from 77.93±8.52 to 91.38±6.41 ($p<0.001$).
Pendidikan Kesehatan dengan Media Infografis Interaktif Meningkatkan Pengetahuan Remaja Mengenai Diabetes Mellitus (Deshinta Adelia Arisna Putri & Yudanari, 2025)	Grade VIII students at SMP Negeri 1 Banyubiru; n=67	One-group pretest–posttest	Interactive infographic-based health education	Knowledge increased significantly following education ($p<0.001$). Mean scores were not reported in the abstract.
Pengaruh Edukasi Kesehatan Dengan Media Booklet Terhadap Pengetahuan Dan Sikap Pencegahan Diabetes Mellitus Pada Remaja Di Sma Negeri I Samudera Kabupaten Aceh Utara (Hamid Et Al., 2025)	SMA Negeri 1 Samudera, North Aceh; n=72 or 74*	Quasi-experimental one-group pretest–posttest	Booklet-based health education	Knowledge improved significantly ($p<0.001$), as did attitude ($p=0.001$). Attitude scores increased from 28.54 to 35.00.
Pengaruh Edukasi Multimedia Terhadap Peningkatan Pengetahuan, Sikap, Dan Perilaku Remaja Dalam Pencegahan Penyakit Diabetes Melitus Di Kecamatan Cakung Jakarta Timur (Suryati Et Al., 2025)	Grades X–XI at SMA YPI, Cakung, East Jakarta; n=70: intervention=40 and control=30	Quasi-experimental pretest–posttest control group	A 10-minute animated video delivered weekly for eight weeks	Compared with the control group, the intervention significantly improved knowledge ($p<0.001$), attitude ($p=0.009$), and behavior ($p<0.001$).

The Impact Of Health Education Through Audio-Visual Media On Increasing Knowledge Of Type 2 Diabetes Prevention Among Students (Lukman Et Al., 2025)	Grade XI students at SMA Negeri 23 Makassar; n=138	Pre-experimental one-group pretest–posttest	Audiovisual health education	Median knowledge increased from 10 (range 5–16) to 19 (range 7–21; p<0.001).
Effectiveness Of Digital Book-Based Discussions On Type 2 Diabetes Prevention In Obese-Risk Adolescents (Cahyati Et Al., 2025)	Adolescents at risk of obesity at SMA Negeri 7 Bengkulu; n=74: intervention=37 and control=37	Quasi-experimental pretest–posttest control group	Discussion using a digital book	Prevention behavior improved significantly in the intervention group (p<0.001), with a greater improvement than in the control group.
Pengaruh Edustacno (Game Stacko Uno) Diabetes Mellitus Terhadap Peningkatan Pengetahuan Dan Sikap Pada Siswa Sman 1 Kedungwuni Kabupaten Pekalongan (Priyanto Et Al., 2025)	Students at SMA Negeri 1 Kedungwuni, Pekalongan; n=60	Quasi-experimental one-group pretest–posttest	EDUSTACNO educational game using Stacko Uno	Knowledge increased from 10.08 to 17.15 (p<0.001), while attitude increased from 32.07 to 33.58 (p=0.017).
Effect Of Diabetes Mellitus Educational Video On Knowledge Improvement Among Adolescents In Indonesia (Puspita Et Al., 2025)	Students at SMA Bina Cipta Palembang; n=42	Pre-experimental one-group pretest–posttest	Diabetes educational video	The video intervention significantly increased knowledge (p<0.001). Numerical pretest and posttest scores were not presented in the abstract.
Efektivitas Edukasi Dini Menggunakan Leaflet Terhadap Peningkatan Pengetahuan Diabetes Melitus Pada Siswa Mtss Nurhasanah Labuhan Ruku (Barus Et Al., 2025)	Grades VII–VIII at MTsS Nurhasanah Labuhan Ruku; n=31	Quasi-experimental one-group pretest–posttest	Leaflet-based education	Mean knowledge increased from 6.81±1.14 to 8.55±1.03 (p<0.001), with a large effect size (Cohen's d=1.549).

Pengaruh Edukasi Kesehatan Berbasis Flyer Terhadap Pengetahuan Risiko Diabetes Pada Remaja Di Sma Negeri 9 Pekanbaru (Hidayah Et Al., 2026)	Grades X–XII at SMA Negeri 9 Pekanbaru; n=34	One-group pretest–posttest	A 30-minute face-to-face session using a flyer; immediate posttest	Mean knowledge increased from 11.11±1.67 to 15.76±1.89; median increased from 11 to 16 (p=0.001).
Effectiveness Of School-Based Peer Education On Knowledge, Attitudes, And Behavior Of Diabetes Mellitus Prevention Among Adolescents (Nursyamsiyah Et Al., 2026)	Students at a private junior high school in Bandung; n=90: intervention=45 and control=45	Quasi-experimental pretest–posttest control group	Four weekly peer-education sessions, each lasting 60 minutes	Compared with the control group, knowledge (p=0.001) and attitude (p=0.005) improved significantly, but preventive behavior did not (p=0.802).
The Effect Of Dialearn (Diabetes E-Learning) On The Level Of Knowledge About Type Ii Diabetes Mellitus In Godean Yogyakarta (Milataki Et Al., 2026)	Grade X students at SMK Negeri 2 Godean, Yogyakarta; n=74: intervention=37 and control=37	Quasi-experimental pretest–posttest control group	DIALEARN diabetes e-learning	DIALEARN produced a significant between-group improvement in knowledge (p=0.020).
Efektivitas Edukasi Multimedia Dalam Meningkatkan Pengetahuan, Sikap, Dan Perilaku Remaja Dalam Pencegahan Diabetes Mellitus (Wartonah Et Al., 2026)	Grade XII students at SMA Harapan Kasih, North Jakarta; n=60: intervention=30 and control=30	Quasi-experimental pretest–posttest control group	A 10-minute educational video delivered twice over two weeks; control received a leaflet	Video education significantly improved knowledge (p=0.009; d=0.42), attitude (p=0.002; d=0.61), and behavior (p=0.003; d=0.48).
The Effect Of Animation Book–Based Education On Adolescents' Knowledge And Attitudes Toward Diabetes Mellitus Prevention: A Quasi-Experimental Study At Muhammadiyah 1 Junior High School, Sidoarjo, Indonesia (Fauzan Et Al., 2026)	Grade IX students at SMP Muhammadiyah 1 Sidoarjo; n=64: animation book=32 and leaflet=32	Quasi-experimental non-equivalent control group	Animation book compared with a conventional leaflet	Knowledge and attitude improved significantly in the animation-book group compared with the leaflet group (p=0.001). Good knowledge increased from 40.6% to 93.8%.

Pengaruh Edukasi Kesehatan Terhadap Tingkat Pengetahuan Pencegahan Diabetes Melitus Pada Siswa Smp Negeri 5 Kendari (Paridah Et Al., 2026)	Students at SMP Negeri 5 Kendari; n=33	Pre-experimental one-group pretest–posttest	School-based health education; specific media were not clearly reported	Very good knowledge increased from 24.2% to 69.7%. After education, no participants remained in the fair-knowledge category. Only descriptive results were reported.
Analisa Efektivitas Kegiatan Sosialisasi Kesehatan Tentang Diabetes Melitus Terhadap Tingkat Pengetahuan Pada Siswa Sma Islam Al-Ulum Tahun 2023 (Perdana Et Al., 2026)	Grade XII-MIA students at SMA Islam Al-Ulum; n=56	One-group pretest–posttest	School-based diabetes health socialization	Knowledge increased significantly following the program (p=0.0001). Inclusion remains conditional because the intervention addressed diabetes generally rather than explicitly focusing on T2DM prevention.

Of the 16 studies, ten employed a one-group pretest–posttest design, whereas six used quasi-experimental designs involving intervention and comparison groups. Sample sizes ranged from 29 to 138 students, and the participants came from junior high schools, senior high schools, vocational schools, and Islamic secondary schools. Audiovisual and digital strategies included educational videos, animated videos, interactive infographics, digital books, e-learning, and animation books. Other studies used booklets, leaflets, flyers, educational games, peer education, and general health-education sessions. Knowledge was the most frequently assessed outcome, while fewer studies evaluated attitudes and diabetes-prevention behaviors.

Overall, the studies reported favorable changes following the educational interventions, particularly in students' knowledge of diabetes risk factors and prevention. Most studies assessing knowledge demonstrated statistically significant improvements, although Paridah et al. reported only descriptive changes without inferential testing. Significant improvements in attitude were also reported in studies using booklets, educational games, multimedia, peer education, and animation books. Behavioral findings were less consistent: Suryati et al., Cahyati et al., and Wartonah et al. reported significant improvements, whereas Nursyamsiyah et al. found no significant effect on preventive behavior. Collectively, the findings indicate that school-based education has produced the most consistent evidence for short-term knowledge improvement, while evidence concerning sustained behavioral change remains limited.

DISCUSSION

This mini-review identified 16 primary research articles examining educational strategies for the prevention of type 2 diabetes mellitus (T2DM) among junior and senior secondary school students in Indonesia. The strategies were diverse and included interactive infographics, educational videos, audiovisual materials, animated multimedia, booklets, leaflets, digital book-based discussions, and educational games. Overall, all studies reported improvements in at least one outcome following the interventions, although most employed a one-group pretest–posttest design. Increased knowledge was the most consistently reported finding, as demonstrated by interventions using interactive infographics, booklets, educational videos, audiovisual materials combined with leaflets, and the EDUSTACNO educational game. In contrast, attitudes were assessed in only a few studies, while behavioral changes were mainly reported in studies involving repeated multimedia education and digital book-based discussions. Therefore, positive effects on attitudes and behaviors have not been established consistently, primarily because these outcomes were assessed less frequently than knowledge.

The improvement in knowledge observed across different media suggests that information about T2DM prevention can be effectively delivered through both digital and printed formats, provided that the content is clearly presented and appropriate for students' characteristics. Interactive infographics can simplify information concerning risk factors and preventive measures through a combination of text and visual elements, whereas videos, audiovisual materials, and animated multimedia allow students to receive information simultaneously through visual and auditory channels. Booklets and leaflets enable students to revisit information at their own learning pace, while educational games promote active engagement through questions, challenges, and immediate feedback. The similarities in findings across studies may be attributed to the use of simple language, the presentation of information in short and manageable sections, relevant illustrations, and the reinforcement of key messages concerning dietary patterns, physical activity, obesity, and T2DM risk. This explanation is consistent with the review by Çeken and Taşkın (2022), which indicated that combining verbal and visual representations can facilitate understanding when aligned with learning objectives and learners' abilities. Nevertheless, effectiveness cannot be attributed solely to the media format because content quality, exposure duration, facilitation, and opportunities to revisit the material may also influence learning outcomes.

Compared with knowledge, the effects of educational interventions on students' attitudes were investigated in fewer studies. Booklet-based education was reported to improve both knowledge and attitudes, while the EDUSTACNO game produced positive changes by promoting a more active and enjoyable learning experience. An animated multimedia intervention delivered regularly also improved students' attitudes, which may have been related to repeated exposure and reinforcement of the educational messages throughout the program (Suryati et al., 2025). However, improved knowledge does not necessarily lead directly to attitudes that support T2DM prevention. Attitudes are also influenced by students' perceptions of disease susceptibility, beliefs about the benefits of lifestyle changes, personal experiences, peer norms, family support, and confidence in their ability to adopt healthy behaviors. A systematic review by Dodd et al. (2022) similarly found that school-based health education interventions produced more consistent improvements in knowledge than in behavior. Therefore, educational interventions intended to shape attitudes should not be limited to communicating factual information but should also include reflective discussions, examples relevant to adolescents' daily lives, goal-setting activities, and social support (Nevitaningrum et al., 2026).

Evidence regarding behavioral change in the reviewed articles was more limited than evidence concerning improvements in knowledge. Behavioral improvements were mainly reported following an animated multimedia intervention delivered weekly for eight weeks and a digital book-based discussion intervention. These findings indicate that repeated education and learning activities that allow students to discuss and apply information may be more likely to encourage behavioral change than a single educational session. Behaviors such as reducing sugar-sweetened beverage consumption, choosing healthier foods, increasing physical activity, and limiting sedentary time represent established habits influenced by food availability, the school environment, family practices, peer groups, and daily routines. Sugar-sweetened beverage consumption remains an important concern in Indonesia and is associated with several adverse health consequences, as described by Sartika et al., (2022). Moreover, high levels of sedentary behavior and insufficient physical activity among Indonesian children and adolescents have been reported by Hanifah et al., (2023). Consequently, behavioral change requires time, practice, monitoring, message reinforcement, and supportive school and family environments that enable students to make healthier choices.

Each educational strategy has advantages and limitations that should be considered. Digital media, including videos, infographics, multimedia materials, and digital books, are appealing to adolescents, can be distributed widely, and can be used repeatedly. However, their implementation depends on the availability of devices, internet connectivity, and users' digital competence. Printed media, such as booklets and leaflets, are relatively inexpensive, portable, and suitable for self-directed learning, although they provide limited interaction and do not ensure that students will revisit the material. Games and discussions can promote participation, collaboration, and immediate feedback but require sufficient time, trained facilitators, and consistency of implementation. Although peer education was not a dominant strategy among the reviewed studies, it may improve message acceptance through shared experiences and age-appropriate communication. Widnall et al., (2024) demonstrated that peer connectedness, credibility, teacher support, and school culture are important mechanisms underlying peer education. Differences in study design, intervention duration and frequency, facilitator characteristics, student characteristics, measurement instruments, comparison groups, and follow-up periods prevent direct comparisons among strategies. Therefore, the available evidence is insufficient to identify any single medium as the most effective educational strategy.

Based on this synthesis, schools could develop a multicomponent T2DM prevention education program coordinated through the School Health Unit or *Usaha Kesehatan Sekolah* (UKS). The program could begin with short videos or infographics explaining T2DM risk factors, followed by classroom discussions, educational games, demonstrations on reading food labels, and activities in which students identify the sugar content of commonly consumed beverages. Trained students could be involved as peer educators to reinforce key messages and establish group norms that support healthy lifestyles. Educational components should be integrated with the provision of drinking water, restrictions on sugar-sweetened beverages in school canteens, healthier food choices, scheduled physical activity, active classroom breaks, sedentary behavior reduction, parental involvement, and assistance from local community health centers or Puskesmas. These recommendations are consistent with the review by Himalowa et al., (2020), which emphasized the importance of combining nutrition education, physical activity, competency development, and environmental support in preventing T2DM among schoolchildren. A network meta-analysis by Nikooyeh et al., (2025) also indicated

that combining health education, physical activity, and school policies may be more promising for addressing obesity-related risk factors than health education alone.

The findings of this mini-review have implications for schools, teachers, healthcare professionals, UKS administrators, and researchers. Schools can select combinations of educational media based on available resources and student characteristics. For example, schools with limited technological facilities may combine booklets, games, and discussions, while schools with adequate digital facilities may use videos or multimedia materials supplemented by interactive activities. Teachers can integrate preventive messages into classroom learning and provide reinforcement periodically, while healthcare professionals should ensure the scientific accuracy of the content, train facilitators, and assist in identifying students who require further health services. UKS administrators can coordinate health education, school canteen policies, physical activity programs, parental involvement, and collaboration with Puskesmas. This is important because Prihanto et al., (2021) demonstrated an association between health literacy and health behaviors among Indonesian high school students while also indicating that the implementation and coordination of school health programs require further strengthening. Researchers should develop interventions with more standardized content and dosage, employ validated instruments and control groups, assess implementation fidelity, and conduct long-term evaluations of knowledge, attitudes, self-efficacy, dietary intake, physical activity, and sedentary behavior.

This mini-review has several limitations that should be considered when interpreting its findings. Restricting the publication period to January 2025–June 2026 resulted in a relatively small number of eligible articles and may not represent the full development of T2DM prevention education in Indonesia. Searches conducted through selected databases and information sources may also have overlooked articles that were not indexed, used different terminology, or were not available in full text. Furthermore, journals' tendency to publish studies reporting positive findings may have introduced publication bias. The reviewed articles were heterogeneous in their designs, sample sizes, student characteristics, educational media, intervention duration and frequency, measurement instruments, and assessed outcomes. Most studies used a one-group design with outcomes measured immediately after the intervention, making their results susceptible to testing effects, attention effects, and factors unrelated to the intervention. Attitude and behavioral measurements that relied primarily on students' self-reports may also have introduced response bias. Because the findings were synthesized narratively without a meta-analysis, a pooled effect size could not be calculated, and the relative superiority of the educational strategies could not be established. Therefore, the conclusions of this review primarily demonstrate patterns in the evidence and directions for program development rather than definitive evidence regarding the most effective medium or the long-term sustainability of behavioral changes.

CONCLUSION

This mini-review concludes that educational strategies using interactive infographics, videos, audiovisual media, animated multimedia, booklets, leaflets, digital books, and educational games generally improve secondary school students' knowledge of type 2 diabetes mellitus prevention in Indonesia. Improvements in attitudes and preventive behaviors were also reported, but the evidence remains limited because these outcomes were assessed less frequently and most studies used short-term, one-group pretest–posttest designs. Effective school-based prevention should therefore extend beyond a single educational medium by combining age-appropriate information, interactive learning, peer support, nutrition literacy, reduced consumption of sugar-sweetened beverages, regular physical activity, healthy canteen policies, parental

involvement, and collaboration with community health centers. Schools and School Health Units should adapt these components to available resources and student needs. Future studies should employ controlled designs, validated outcome measures, standardized interventions, and longer follow-up periods to determine sustained behavioral and clinical effects.

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