

# Jurnal Ilmiah Kesehatan Keperawatan

p-ISSN 1858-0696 | e-ISSN 2598-9855

## The effectiveness of a diabetes preventive booklet on adolescents' knowledge levels

Fendi Setiawan, Cahyu Septiwi\*

*Nursing Study Program, Faculty of Health Sciences, Universitas Muhammadiyah Gombong, Jl. Yos Sudarso No. 461, Gombong, Kebumen, Central Java 54412, Indonesia*

### ARTICLE INFO

#### Article history

Received: May 22, 2026

Revised: June 22, 2026

Accepted: June 29, 2026

#### Keywords:

Adolescents,  
Booklet,  
Diabetes mellitus,  
Health education.

### ABSTRACT

Diabetes mellitus is a non-communicable disease whose incidence continues to rise globally, including in Indonesia. The lack of knowledge about diabetes prevention among adolescents is a crucial issue that needs to be addressed early, considering that adolescence is a critical phase for shaping healthy lifestyle behaviors. This study aimed to determine the effect of education through a diabetes mellitus prevention booklet on the level of diabetes mellitus knowledge among adolescents at MTs N 7 Kebumen. This research was a quantitative study using a quasi-experimental method with a one-group pre-test-post-test design. The sample was selected using purposive sampling, with a total of 80 respondents. The research instruments were a diabetes mellitus prevention booklet and a diabetes knowledge questionnaire. Data were analyzed using the Wilcoxon Signed-Rank Test. Before the educational intervention, the majority of respondents (43.8%) had a low level of knowledge. After the intervention using the booklet, a significant improvement was observed, with 90% of respondents achieving a high level of knowledge. The statistical test showed a significance value of  $p < 0.001$ , indicating a significant difference before and after the intervention. These findings indicate that education through a diabetes mellitus prevention booklet has a significant effect on increasing the level of diabetes knowledge among adolescents at MTs N 7 Kebumen.

\* Corresponding author. Cahyu Septiwi, Nursing Study Program, Faculty of Health Sciences, Universitas Muhammadiyah Gombong, Gombong, Kebumen, Central Java 54412, Indonesia. E-mail address: [cahyuseptiwi@unimugo.ac.id](mailto:cahyuseptiwi@unimugo.ac.id).



© 2026 Published by LPPM Universitas Muhammadiyah Gombong. This is an open access article under the CC BY-SA 4.0 license.

### 1. INTRODUCTION

Diabetes mellitus is one of the major global health threats of the 21st century. This disease is characterized by metabolic disorders caused by insulin deficiency or resistance, affecting carbohydrate, lipid, and protein metabolism (Poznyak et al., 2020). Clinically, diabetes can lead to various serious complications, and its symptoms often appear during childhood and adolescence, particularly among individuals with high blood glucose levels (Rossi et al., 2019). The global burden of diabetes continues to increase, rising from 200 million cases in 1990 to 830 million in 2022, and it is projected to reach 783 million by 2045 (International Diabetes Federation, 2025).

The increasing prevalence is also evident in Indonesia. The 2023 Indonesian Health Survey recorded 877,531 diabetes cases, including 139,891 cases among individuals aged 15–24 years. In Central Java, there were 118,184 reported cases, while Kebumen Regency recorded 12,337 cases (Health Development Policy Agency, 2023; Statistics Indonesia of Kebumen Regency, 2023). These data indicate that diabetes is not only a health problem

among adults but is also becoming a significant threat to adolescents.

Unhealthy lifestyle behaviors, including high sugar intake, frequent consumption of fast food, low physical activity, and excessive screen time, are major risk factors for type 2 diabetes among adolescents (Xu et al., 2018; Karssenberget al., 2022). Preliminary findings at MTs N 7 Kebumen showed that most adolescents frequently consumed fast food and sugary beverages, rarely exercised, and had screen time exceeding six hours per day. Furthermore, nearly all respondents reported limited understanding of diabetes and its prevention strategies.

Health education interventions are needed to improve adolescents' understanding of diabetes and the importance of maintaining a healthy lifestyle. Health education has been shown to be highly effective in promoting behavioral changes through improving knowledge, skills, and attitudes (Pueyo-Garrigues et al., 2019). One effective educational medium is the booklet, as it is practical, easy to understand, cost-effective, and capable of presenting information clearly and systematically (Bela et al., 2024).

Several previous studies have demonstrated the effectiveness of booklets in improving diabetes-related knowledge among various populations, including adolescents, pregnant women, and patients with diabetes mellitus (Nurhidayanti et al., 2023; Arya Mamonto et al., 2021; Romalina et al., 2024; Widyastuti et al., 2021). However, studies involving adolescents at the Islamic junior secondary school (Madrasah Tsanawiyah/MTs) level remain limited, despite this age group requiring early preventive interventions.

Considering the high risk of diabetes mellitus among adolescents due to unhealthy lifestyles and their low level of understanding regarding disease prevention, educational interventions through booklet media are both relevant and necessary. Therefore, this study was conducted to analyze the effect of education through a diabetes mellitus prevention booklet on adolescents' knowledge levels at MTs N 7 Kebumen.

Previous studies have also highlighted the effectiveness of booklets as educational tools. Arya Mamonto et al. (2021) found that booklets improved pregnant women's knowledge regarding gestational diabetes prevention. A study by Widyastuti et al. (2021) involving adolescents also demonstrated a positive effect of booklets on dietary knowledge for the early prevention of type 2 diabetes. In addition, Sepang et al. (2020) proved that booklets improved knowledge among patients with type 2 diabetes mellitus. However, most of these studies focused on pregnant women, adult patients, or adolescents with a single-variable focus such as diet, rather than comprehensive diabetes-related knowledge.

The research gap lies in the limited number of studies evaluating the use of booklets as comprehensive educational media to improve diabetes prevention knowledge among adolescents at the Madrasah Tsanawiyah (MTs) level. Moreover, no previous studies have specifically examined this intervention among MTs adolescents in Kebumen Regency. The lack of local data regarding adolescents' knowledge of diabetes further underscores the importance of this study.

The novelty of this study lies in its focus on diabetes prevention education among adolescents aged 12–15 years at the MTs level using a comprehensive booklet independently developed and validated by experts. Unlike previous studies, this research assesses diabetes knowledge comprehensively, covering definitions, etiology, symptoms, complications, risk factors, and preventive measures, making it more relevant for adolescents as a strategic target population in preventive health efforts.

Based on this background, this study aims to analyze the effect of education through a diabetes mellitus prevention booklet on adolescents' knowledge levels at MTs N 7 Kebumen. Specifically, it measures changes in knowledge levels before and after the educational intervention. The study

hypothesis states that education through booklet media has a significant effect on improving adolescents' knowledge regarding diabetes mellitus prevention.

## 2. METHODS

### 2.1 Study Design

This study employed a quasi-experimental design with a one-group pre-test–post-test approach. This design was selected because it was suitable for the school setting, where full randomization of participants was not feasible, while still allowing the evaluation of changes in knowledge levels before and after the educational intervention using a booklet. The study population consisted of all adolescents at MTs N 7 Kebumen.

### 2.2 Setting and Participants

The sample was selected using a purposive sampling technique based on the following inclusion criteria: adolescents aged 12–15 years, ninth-grade students who were present during the study, and those who owned and were able to operate a mobile phone. The exclusion criteria included adolescents with severe visual impairments, those unwilling to participate as respondents, and those who were uncooperative during the study. The final sample consisted of 80 respondents, determined using the Slovin formula based on population size considerations and research feasibility.

### 2.3 Instruments and Measures

The research instrument was a multiple-choice diabetes mellitus knowledge questionnaire developed by the researchers based on theoretical concepts and educational booklet materials. The questionnaire covered several aspects, including definition, classification, etiology, pathophysiology, clinical manifestations, complications, management, prevention, and healthy lifestyle practices. The instrument was validated by three experts in community nursing and medical-surgical nursing and was categorized as “highly valid.” Reliability testing was conducted through a pilot test on respondents with similar characteristics and analyzed using Cronbach's alpha, yielding a coefficient of 0.949, indicating excellent reliability.

### 2.4 Data Collection Procedure

Data collection was carried out in several stages, beginning with respondent selection based on the inclusion criteria, followed by the division of participants into four classes (9A, 9I, 9C, and 9F). A pre-test was then administered using Google Forms accessed through the Diabetes Mellitus Prevention Education thesis website developed by the researchers. Additional mobile phones were provided for respondents who did not bring their own devices. Subsequently, the researchers delivered the educational intervention using the booklet, accompanied by oral explanations and a question-and-answer session. After the intervention,

respondents completed the post-test using the same platform. All collected data were stored anonymously and coded to ensure respondent confidentiality.

## 2.5 Data Analysis

The obtained data underwent editing, coding, data entry, and cleaning before analysis using IBM SPSS version 26. Normality testing showed that the data were not normally distributed; therefore, data analysis was conducted using the Wilcoxon Signed-Rank Test to examine differences in knowledge levels before and after the intervention. All research procedures were conducted in accordance with ethical research principles, including beneficence, non-maleficence, autonomy, confidentiality, and justice. Each respondent received a complete explanation of the study objectives and procedures and signed an informed consent form as evidence of voluntary participation.

## 2.6 Ethical Considerations

This study received ethical approval from the Ethics Committee of Universitas Muhammadiyah Gombong (No. 104.6/II.3.AU/F/KEPK/VII/2025).

## 3. RESULTS

The characteristics of the 80 respondents from MTs N 7 Kebumen, including age, gender, and class, are presented in Table 1.

**Table 1.** Frequency Distribution of Respondents' Characteristics ( $n = 80$ )

| Characteristic | f  | Percentage (%) |
|----------------|----|----------------|
| <b>Age</b>     |    |                |
| 13 years       | 9  | 11.3           |
| 14 years       | 51 | 63.8           |
| 15 years       | 20 | 25.0           |
| <b>Gender</b>  |    |                |
| Female         | 40 | 50.0           |
| Male           | 40 | 50.0           |
| <b>Class</b>   |    |                |
| Class 9A       | 30 | 37.5           |
| Class 9C       | 10 | 12.5           |
| Class 9F       | 9  | 11.3           |
| Class 9I       | 31 | 38.8           |

Source: primary data (2025).  $f$  = frequency; % = percentage.

Based on Table 1, 9 respondents (11.3%) were aged 13 years, 51 (63.8%) were aged 14 years, and 20 (25.0%) were aged 15 years. The respondents were evenly distributed by gender (40 female and 40 male; 50% each). By class, 30 respondents (37.5%) were from Class 9A, 10 (12.5%) from Class 9C, 9 (11.3%) from Class 9F, and 31 (38.8%) from Class 9I.

**Table 2.** Frequency Distribution of Knowledge Levels Before and After Education Through the Diabetes Mellitus Prevention Booklet ( $n = 80$ )

| Knowledge level         | f | Percentage (%) |
|-------------------------|---|----------------|
| <b>Before education</b> |   |                |

|                        |    |      |
|------------------------|----|------|
| Good                   | 24 | 30.0 |
| Moderate               | 21 | 26.3 |
| Poor                   | 35 | 43.8 |
| <b>After education</b> |    |      |
| Good                   | 72 | 90.0 |
| Moderate               | 8  | 10.0 |
| Poor                   | –  | –    |

Source: primary data (2025).

Before the educational intervention, most respondents had poor knowledge (35 respondents; 43.8%), while 21 (26.3%) had moderate knowledge and 24 (30.0%) had good knowledge. After the intervention, most respondents demonstrated good knowledge (72 respondents; 90.0%), 8 (10.0%) had moderate knowledge, and none remained in the poor category.

**Table 3.** Wilcoxon Signed-Rank Test of Knowledge Levels Before and After the Intervention ( $n = 80$ )

| Parameter                  | Value  |
|----------------------------|--------|
| Negative ranks (mean rank) | 9.25   |
| Positive ranks (mean rank) | 37.78  |
| Ties                       | 7      |
| Z                          | –7.331 |
| Asymp. Sig. (2-tailed)     | <0.001 |

Source: primary data (2025). Negative ranks = post-test < pre-test; positive ranks = post-test > pre-test; ties = equal scores.

The Wilcoxon Signed-Rank Test showed a significant difference in knowledge levels before and after the intervention, with a Z-score of –7.331 and a significance value of  $p < 0.001$  ( $p < 0.05$ ). The positive mean rank (37.78) was much higher than the negative mean rank (9.25), indicating that most post-test scores were higher than pre-test scores, while seven respondents obtained identical scores. These results indicate that the alternative hypothesis was accepted: education through the diabetes mellitus prevention booklet significantly improved adolescents' knowledge of diabetes mellitus at MTs N 7 Kebumen.

## 4. DISCUSSION

### 4.1 Principal Findings

#### *Knowledge level before education through the booklet*

The results of this study indicate that education through the diabetes mellitus prevention booklet had a significant effect on respondents' diabetes mellitus knowledge. Before the educational intervention, the majority of respondents were categorized as having poor knowledge (43.8%). Based on the researchers' analysis, this condition was most likely caused by limited access to relevant health information regarding non-communicable diseases such as diabetes mellitus among adolescents. At the junior secondary school level, diabetes mellitus is not yet a major component of the health education curriculum; therefore, students' exposure to information about this disease tends to be limited (Ministry of Health of the Republic of Indonesia, 2021). Without structured

educational interventions, students are unlikely to develop adequate understanding regarding the causes, symptoms, prevention, and risks of diabetes mellitus.

Diabetes prevention interventions, such as healthy lifestyle programs involving nutritional education and physical activity, have also been shown to be effective across all socioeconomic groups, with no significant differences between higher and lower social class groups. For example, Duijzer et al. (2017) reported that participation rates, attendance, program acceptance, adherence, and effects on diabetes risk parameters—including fasting insulin, HbA1c, body weight, and waist circumference—did not differ significantly between low and high socioeconomic status groups after 12 to 18 months of intervention. These findings reinforce the view that diabetes prevention education should be implemented inclusively and comprehensively across all school classes. Educational interventions delivered through booklet media can serve as an effective strategy for promoting equal access to health information and encouraging all adolescents, regardless of academic background, to participate actively in diabetes prevention efforts.

In addition, the low level of respondents' knowledge may also be attributed to the limited availability of health promotion activities in schools, the lack of easily accessible educational media, and low public awareness regarding the importance of diabetes mellitus prevention. This condition is further reinforced by the common perception that diabetes mellitus is primarily a disease affecting adults or older individuals, leading adolescents to believe that they do not need to learn about it in depth.

The limited integration of non-communicable disease education into the school curriculum is another factor contributing to adolescents' lack of formal exposure to information about diabetes mellitus. Although adolescents are active users of the internet and social media, not all of the information they consume contains scientifically valid educational content. Low health literacy also affects their ability to understand health-related information, particularly when it is not presented in age-appropriate ways. A study by Wulandari and Sari (2023) found that adolescents with low health literacy tended to have poor knowledge regarding chronic diseases, including diabetes mellitus.

Furthermore, the role of families in providing health education remains suboptimal, particularly when parents themselves have limited knowledge of diabetes mellitus. Unhealthy lifestyle patterns and unbalanced dietary habits commonly observed among adolescents further increase the risk of developing diabetes mellitus, especially when not accompanied by sufficient knowledge to support preventive behaviors (Nurjanah et al., 2022). These findings highlight the importance of providing structured and age-appropriate health education interventions to

improve adolescents' knowledge and awareness regarding diabetes mellitus prevention.

### ***Knowledge level after education through the booklet***

Following the educational intervention using the booklet, a significant improvement in knowledge levels was observed, with the majority of respondents achieving the good knowledge category (90%). This improvement was evident from the post-test results, which showed a higher number of correct responses compared with the pre-test, and was influenced by several factors related to both the educational method and the characteristics of the respondents.

First, the booklet served as an effective and easily understandable visual educational medium. It was designed using simple language, illustrative images, and systematically organized information, which increased its attractiveness and strengthened students' understanding (Lestari et al., 2022). Printed media such as booklets also allow students to revisit information whenever needed, reinforcing independent learning. Second, the developmental characteristics of adolescents, who are generally in the formal operational stage of cognitive development, enable them to understand abstract concepts such as chronic diseases and their prevention (Santrock, 2019). Third, adolescents' internal motivation and active engagement contributed to the improvement in knowledge. Fourth, a supportive learning environment—teacher assistance, sufficient time to read the booklet, and a comfortable classroom atmosphere—further strengthened the effectiveness of the intervention (World Health Organization, 2021).

Therefore, the improvement in respondents' knowledge was not solely due to the provision of information, but also to the effectiveness of the educational medium, adolescents' cognitive readiness, the relevance of the material, and the supportive learning environment. Educational interventions conducted in small groups have also been shown to be more effective than those delivered in larger groups because they provide greater opportunities for intensive interaction between facilitators and participants, facilitating a more in-depth and personalized two-way learning process (Timiyatun et al., 2021).

### ***The effect of education on knowledge levels before and after the intervention***

Statistical testing showed a significance value of  $p < 0.001$  ( $p < 0.05$ ), indicating a significant difference in knowledge levels before and after the educational intervention. This means that the alternative hypothesis was accepted, confirming that education through the booklet had a significant effect on improving adolescents' knowledge of diabetes mellitus at MTs N 7 Kebumen. These findings demonstrate that the booklet is an effective and appropriate educational medium for adolescents,

presenting information systematically, concisely, and in an easily understandable manner.

In the context of school-based health promotion, booklets are highly relevant educational tools because they can reach all adolescents without relying on digital technology, supporting the concept of schools as centers for health promotion recognized by the World Health Organization (World Health Organization, 2021). Visual educational media such as booklets have been shown to stimulate memory retention and comprehension more effectively than verbal explanations alone (Notoatmodjo, 2020), consistent with the findings of Sari and Wulandari (2021), who reported that booklet use significantly improved junior secondary school students' knowledge regarding the prevention of non-communicable diseases.

From a cognitive perspective, this improvement can also be explained through Bruner's learning theory, which states that learning is more effective when material is presented through visual and representational media, facilitating understanding of complex concepts through concrete experiences (Bruner, 2020). In this study, the booklet was accessed by respondents a total of 159 times and combined text, images, and systematic presentation, making it easier for adolescents to internalize information. Improving knowledge during adolescence is essential because this is the stage at which behavioral patterns and attitudes begin to form and often persist into adulthood (World Health Organization, 2025).

#### 4.2 Comparison with Previous Studies

The findings of this study indicate that selecting early adolescents as the target population was an appropriate strategy for health education interventions. Adolescents at this stage are relatively more receptive to new information, possess a high level of curiosity, and are in the process of identity formation, including lifestyle development (Purwanto et al., 2022). A study by Peña et al. (2022) found that Latino adolescents with prediabetes who participated in a six-month diabetes prevention program experienced significant improvements in insulin sensitivity and reductions in two-hour postprandial blood glucose levels, with improved quality of life compared with the control group.

Similar findings were reported by Bani Salameh et al. (2017), who implemented a 12-week school-based educational program among adolescents aged 12–18 years in Jordan who were at high risk of developing diabetes; the results showed an average weight reduction of 3.3 kg and a decrease in fasting blood glucose of 1.36 mg/dL following the intervention. These findings suggest that school-based education can have measurable effects on diabetes risk factors through both increased knowledge and behavioral change, and can therefore be considered a long-term investment in the prevention of non-communicable diseases at the population level (Rahmawati et al., 2023).

Based on the researchers' analysis, gender differences may have several implications for diabetes prevention potential; however, both genders play equally important roles in preventive efforts. A meta-analysis by Glechner et al. (2018) reported that lifestyle interventions were effective in reducing the risk of type 2 diabetes among both males and females, with no significant differences in effectiveness between genders. A systematic review by Shirvani et al. (2021) also found that community-based educational interventions significantly reduced diabetes risk parameters in both genders. Furthermore, Nugroho and Suparmi (2022) demonstrated no significant difference between males and females in knowledge improvement following diabetes-related educational interventions, supporting the notion that all individuals, regardless of gender, are equally capable of receiving, understanding, and applying health information.

A study by Duhu (2022) demonstrated that health education conducted in smaller groups resulted in more significant improvements in knowledge, attitudes, and adherence compared with education delivered in larger groups, because participants in smaller groups tend to feel more comfortable, focused, and motivated to engage actively. Similar findings were reported by Surianti et al. (2019), who found that small-group discussion methods were effective in improving adolescents' knowledge of HIV/AIDS in secondary schools. Therefore, the implementation of booklet-based education in small groups was considered effective in enhancing adolescents' comprehension of diabetes mellitus prevention material, as reflected in the increased post-test scores.

Mayer (2017) emphasized that educational materials accompanied by images, diagrams, or other visual aids improve retention and long-term understanding. Because booklets integrate these elements, they strengthen information encoding and facilitate storage in long-term memory. Several previous studies have also supported the advantages of booklet-based education: Nuraini and Wulandari (2021) found that booklet-based education significantly improved adolescents' knowledge of non-communicable diseases; Indrawati et al. (2020) reported that booklets improved information retention and were more effective than lecture-based methods; Wijayanti and Mulyadi (2019) confirmed that booklet use significantly improved hypertension patients' knowledge; and Amukti et al. (2024) reported that booklet-based education increased health vocational students' knowledge by 74%. The findings are also consistent with Nurhidayanti et al. (2023), who found that nutritional education using e-booklets significantly improved both knowledge ( $p = 0.000$ ) and attitudes ( $p = 0.038$ ).

#### 4.3 Interpretation and Implications

From a health promotion perspective, booklets offer strategic advantages because they support improvements in health literacy. According to the

World Health Organization (2025), adolescents require educational materials that are relevant, clear, engaging, and easily accessible to foster preventive mindsets toward non-communicable diseases. Booklets fulfill all these criteria: they are portable, can be read anytime, are inexpensive to produce, and can be reused repeatedly. Thus, booklets encourage adolescents' independence in seeking and understanding health information while strengthening their internal motivation to maintain healthy lifestyles.

Health education itself is a systematic effort aimed at improving individuals' knowledge, skills, and attitudes related to health. According to the World Health Organization (2025), health education is intended to strengthen people's ability to maintain and improve their physical, mental, and social well-being. Notoatmodjo (2020) explains that knowledge is acquired through experience and learning processes, including reading, formal education, and participation in health education activities, and is influenced by factors such as educational level, information availability, personal experience, social environment, culture, and economic conditions.

## 5. CONCLUSION AND RECOMMENDATIONS

This study demonstrates that education through a diabetes mellitus prevention booklet had a significant effect on improving the knowledge levels of adolescents at MTs N 7 Kebumen, as indicated by the clear differences between pre-test and post-test scores. These findings confirm that the booklet is an effective health education medium for improving adolescents' understanding of the basic concepts of diabetes, its risk factors, symptoms, complications, and preventive measures.

Practically, this study provides important implications for schools, community health centers (Puskesmas), and healthcare professionals, as booklets can be used as low-cost, easily accessible educational media to support school health unit activities and non-communicable disease prevention programs for adolescents. For future research, it is recommended that the sample coverage be expanded to include more schools so that the findings become more representative, that other educational media such as videos or digital applications be compared, and that longitudinal studies be conducted to assess whether the improvement in knowledge contributes to sustainable healthy-lifestyle behavior change among adolescents.

## DATA AVAILABILITY STATEMENT

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

## FUNDING

The authors received no specific funding for this work.

## CONFLICT OF INTEREST

The authors declare no competing interests.

## REFERENCES

- Badan Pusat Statistik Kabupaten Kebumen. (2023). *Jumlah kasus 10 penyakit terbanyak di Kabupaten Kebumen*. Retrieved from <https://kebumenkab.bps.go.id/id/statistics-table/1/OTMjMQ==/jumlah-kasus-10-penyakit-terbanyak-di-kabupaten-kebumen-2023.html>
- Bandura, A. (2024). Health promotion by social cognitive means. *Health Education and Behavior*, 31(2), 143–164. <https://doi.org/10.1177/1090198104263660>
- Bani Salameh, A., Al-sheyab, N., El-hneiti, M., Shaheen, A., Williams, L. M., & Gallagher, R. (2017). Effectiveness of a 12-week school-based educational preventive programme on weight and fasting blood glucose in “at-risk” adolescents of type 2 diabetes mellitus: a randomized controlled trial. *International Journal of Nursing Practice*, 23(3), 1–8. <https://doi.org/10.1111/ijn.12528>
- Bela, P., Safitri, E., Sudaryanto, A., & Yani, A. (2024). Effectiveness of health education with booklet media on knowledge in pharmacological management of hypertension in the Pajang Health Center working area. *Eduhealth*, 15(1). <https://doi.org/10.54209/eduhealth.v15i01>
- Bruner, J. S. (2020). *Toward a theory of instruction*. Cambridge: Harvard University Press.
- Duhu, L. (2022). The effectiveness of small group discussions in improving knowledge, attitudes, and compliance of adolescent girls in consuming iron. *Journal Borneo*, (182).
- Glechner, A., Keuchel, L., Affengruber, L., Titscher, V., Sommer, I., Matyas, N., Wagner, G., Kien, C., Klerings, I., & Gartlehner, G. (2018). Effects of lifestyle changes on adults with prediabetes: a systematic review and meta-analysis. *Primary Care Diabetes*, 12(5), 393–408. <https://doi.org/10.1016/j.pcd.2018.07.003>
- International Diabetes Federation. (2022). *Diabetes around the world in 2021*. Retrieved from <https://diabetesatlas.org/>
- Lestari, R. D., Handayani, F., & Putri, A. P. (2022). Media booklet as an effective tool to improve adolescent knowledge about diabetes mellitus prevention. *Jurnal Keperawatan Indonesia*, 25(3), 211–218.
- Mayer-Davis, E. J., Lawrence, J. M., Dabelea, D., Divers, J., Isom, S., Dolan, L., ... Wagenknecht, L. (2017). Incidence trends of type 1 and type 2 diabetes among youths, 2002–2012. *New England Journal of Medicine*, 376(15), 1419–1429. <https://doi.org/10.1056/nejmoa1610187>
- Ministry of Health of the Republic of Indonesia. (2022). *Pedoman pelaksanaan UKS: Usaha Kesehatan Sekolah sebagai sarana promosi dan pencegahan penyakit tidak menular di sekolah*. Jakarta: Kementerian Kesehatan RI.
- Notoatmodjo, S. (2020). *Promosi kesehatan dan perilaku kesehatan*. Jakarta: PT Rineka Cipta.
- Nurhidayanti, N., Ambarwati, R., & Jaelani, M. (2023). Media e-booklet dapat berpengaruh terhadap pengetahuan dan sikap untuk pencegahan DM tipe 2 pada remaja. *Jurnal Riset Gizi*, 11(2).
- Nurjanah, S., Lestari, R. M., & Yulianti, R. (2022). Peran keluarga dan sekolah dalam peningkatan pengetahuan remaja mengenai penyakit tidak menular. *Jurnal Kesehatan Masyarakat*, 10(1), 22–30. <https://doi.org/10.20473/jkm.v10i1.2022.22-30>

- Poznyak, A., Grechko, A. V., Poggio, P., Myasoedova, V. A., Alfieri, V., & Orekhov, A. N. (2020). The diabetes mellitus–atherosclerosis connection: the role of lipid and glucose metabolism and chronic inflammation. *International Journal of Molecular Sciences*, 21(5), 1835. <https://doi.org/10.3390/ijms21051835>
- Pueyo-Garrigues, M., Whitehead, D., Pardavila-Belio, M. I., Canga-Armayor, A., Pueyo-Garrigues, S., & Canga-Armayor, N. (2019). Health education: a Rogerian concept analysis. *International Journal of Nursing Studies*, 94, 131–138. <https://doi.org/10.1016/j.ijnurstu.2019.03.005>
- Purwanto, B., Ihsana, N., Nashuha, A. R., & Yuniasih, D. (2022). Knowledge of diabetes mellitus and student healthy lifestyle behavior. *Ahmad Dahlan Medical Journal*, 3(2), 102–114.
- Rahmawati, L., Putri, D. K., & Sari, M. A. (2023). The effectiveness of health education in increasing adolescents' knowledge and behavior regarding non-communicable disease prevention. *Jurnal Promkes: The Indonesian Journal of Health Promotion and Health Education*, 11(1), 34–41. <https://doi.org/10.20473/jpk.V11.I1.2023.34-41>
- Romalina, R., Daniati, M., Putri, R. N., & Jasda, A. (2024). The effectiveness of booklets on family knowledge of diabetes mellitus patients about the management of hypoglycaemia. *Healthcare in Low-Resource Settings*, 12(1). <https://doi.org/10.4081/hls.2023.11981>
- Santrock, J. W. (2019). *Adolescence* (17th ed.). New York: McGraw-Hill Education.
- Sepang, M. Y., Patandung, V. P., & Rembet, Y. (2020). *Pengaruh edukasi terstruktur dengan media booklet terhadap tingkat pengetahuan pasien diabetes melitus tipe 2*. Tomohon: Akademi Keperawatan Gunung Maria.
- Shirvani, T., Javadivala, Z., Azimi, S., Shaghaghi, A., Fathifar, Z., Bhalla, H. D. R., Abdekhoda, M., & Nadrian, H. (2021). Community-based educational interventions for prevention of type II diabetes: a global systematic review and meta-analysis. *Systematic Reviews*, 10(1), 1–12. <https://doi.org/10.1186/s13643-021-01619-3>
- Timiyatun, E., Yanuar, I. M. M., Asrifah, U. D., & Oktavianto, E. (2021). The effective small group discussion to improve adolescent knowledge on HIV/AIDS prevention. *Caring: Indonesian Journal of Nursing Science*, 3(1), 38–46. <https://doi.org/10.32734/ijns.v3i1.6006>
- Widyastuti, W., Rofiqoh, S., Isyti'aroh, & Khuzaiyah, S. (2021). Booklet pencegahan diabetes melitus dan pengetahuan diet remaja sebagai upaya pencegahan dini diabetes melitus tipe 2. *Edumasda*. <http://openjournal.masda.ac.id/index.php/edumasda>
- World Health Organization. (2021). *Health promotion for children and adolescents*. Retrieved from <https://www.who.int/news-room/fact-sheets/detail/adolescent-health>
- World Health Organization. (2025). *Management of diabetes mellitus: standards of care and clinical practice guidelines*.