



## Smart snack module using peer learning to improve biological science literacy

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### ABSTRACT

Non-communicable diseases (NCDs) and adolescent malnutrition remain significant public health challenges, particularly among school-aged populations. Unhealthy snacking behaviors, combined with limited science literacy, reduce adolescents' ability to make informed dietary decisions, underscoring the urgent need for effective, school-based educational interventions. This study aimed to develop and assess the effectiveness of a Smart Snack Strategy e-module that integrates peer education and problem-based learning (PBL) to enhance science literacy. The research used a Research and Development (R&D) approach with the ADDIE model, comprising needs analysis through health screening and stakeholder consultation, followed by design, development, expert validation, and product trials. The e-module covers three main topics: the smart snack concept, basic food microbiology, and food label reading. Validation by content, language, media, and learning experts confirmed that the module is highly feasible in terms of quality and usability. Subsequent limited and broader trials with 25 students demonstrated a significant improvement in science literacy, with an average gain of 30.92 points ( $p < 0.05$ ). The e-module also fostered greater motivation, problem-solving skills, and healthier snack decision-making. These findings indicate that integrating peer education and PBL is effective in promoting active learning and healthy lifestyle behaviors. Therefore, the Smart Snack Strategy e-module represents a viable and innovative medium for enhancing science literacy and supporting adolescent health promotion in school settings.

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## INTRODUCTION

Non-communicable diseases (NCDs) such as metabolic syndrome, including obesity, diabetes, hypertension, and cardiovascular diseases, represent a growing global health problem among adolescents (Farhangi et al., 2020). These conditions are strongly associated with unhealthy dietary habits, particularly the consumption of snacks high in sugar, salt, and fat but low in fiber, vitamins, and minerals, such as sugar-sweetened beverages (Jia et al., 2012); (Min et al., 2017), fast food (Fatmawati et al., 2020); (Grimes et al., 2021), and soft drinks (He et al., 2008). Adolescence is a critical period during which dietary habits are established and may persist into adulthood, increasing the risk of non-communicable diseases (Schneider et al., 2021). Unhealthy snacking patterns, particularly the consumption of energy-dense foods high in sugar, salt, and fat, are associated with obesity and other cardiometabolic risks among adolescents (He et al., 2008). Limited science and food literacy further constrain adolescents' ability to make informed dietary choices, highlighting the need for effective school-based educational interventions (Ares et al., 2024).

Adolescence is a critical developmental stage where dietary habits are formed and persist into adulthood, directly influencing the risk of NCDs later in life (Schneider et al., 2021). However, international evidence indicates that many adolescents demonstrate limited science literacy, which constrains their ability to understand health-related information, evaluate nutrition claims, and apply scientific concepts in everyday decision-making (Mancone et al., 2024). This limitation hinders adolescents' ability to make informed health-related decisions. Meanwhile, the Ministry of Health and nutrition campaigns and smart snack educational materials are largely directed toward canteen managers or schools, not directly engaging students (BPOM, 2021). Thus, there is a gap in contextual, interactive, and student-centered media that integrates health content with science literacy, providing adolescents with the skills needed to critically evaluate food choices.

This study proposes to develop an e-module on smart snacking using peer education and problem-based learning (PBL) approaches (Ekubagewargies et al., 2025). The e-module development follows the ADDIE model (Analysis, Design, Development, Implementation, Evaluation) to ensure systematic planning and evaluation (Abuhassna et al., 2024). The research aims to produce a valid and feasible module capable of improving junior high school students' science literacy, specifically focusing on smart snack concepts, basic food microbiology, and food label literacy. Ares et al. (2024), the e-module is expected to promote collaborative learning and problem-solving skills through peer interaction, thereby supporting both knowledge acquisition and behavioral change in making healthier snack choices.

The development of this e-module is grounded in the social cognitive theory and the theory of planned behavior, recognizing that adolescent food choices are strongly influenced by peers, taste, price, and availability rather than scientific reasoning (Ares et al., 2024)(Ekubagewargies et al., 2025). Peer education has been shown to effectively improve adolescents' nutritional behaviors (Ghasemi et al., 2019)(Kim et al., 2023), while PBL enhances creativity, critical thinking, and problem-solving skills, supporting the achievement of Sustainable Development Goals (Damayanti, 2024)(Hidayati NL dan Rachmadiarti, 2024)(Setiawan, 2022). Previous educational media, such as healthy snack pocketbooks (Novelasari & Hayati, 2022) have contributed to knowledge dissemination but lack interactive features and integration of peer education and PBL. Digital-based media have proven effective in fostering engagement, accessibility, and digital literacy (Shanka Resia et al., 2024)(Mancone et al., 2024). Therefore, this study is expected to generate a contextual, innovative, and interactive e-module that is valid, feasible, and effective in improving adolescents' science literacy and supporting healthy snacking behaviors as an early prevention of NCDs. Recent studies indicate that peer education and problem-based learning improve adolescent health learning outcomes (Ekubagewargies et al., 2025). However, adolescence remains a critical period where unhealthy dietary behaviors persist, creating an urgent need for effective interventions. To address this gap, this study is novel in developing an integrated smart snack e-module using peer education and PBL.

## METHODS

### Research Design

This study employed a research and development (R&D) design using the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) (Branch, 2009) to produce a Smart Snack Strategy e-module based on peer education and Problem-Based Learning (PBL). The ADDIE model was

chosen because of its systematic and flexible nature, making it suitable for developing learning media oriented toward students' needs (Abuhassna et al., 2024). The analysis stage involved identifying real health problems in schools through input from the Health Office and the Community Health Center, as well as analyzing the science curriculum. The design stage included structuring the main content, which covered the concepts of smart snacks, food microbiology, and food label literacy. The development stage was conducted through expert validation, followed by limited and broader trials, and was finally evaluated both formatively and summatively to ensure that the resulting module is feasible, practical, and effective in supporting students' scientific literacy and promoting healthy snacking behavior.

### **Population and Samples**

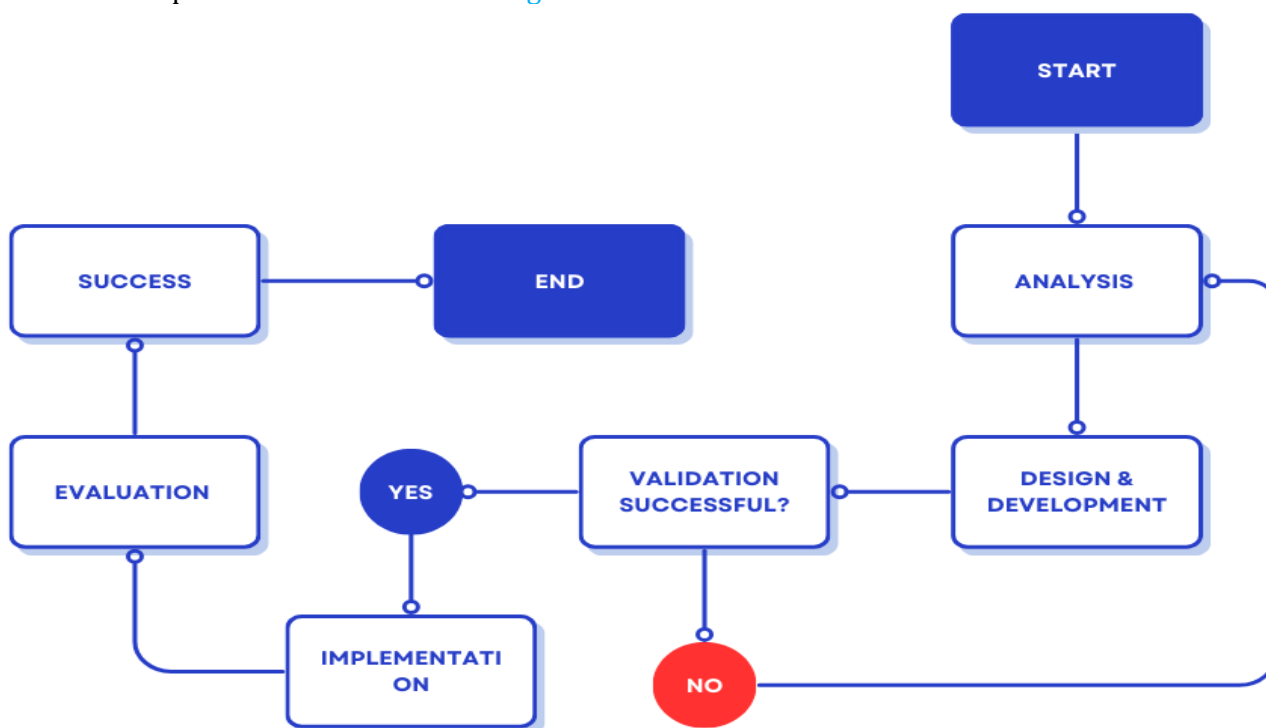
The study population consisted of all students at Madrasah Tsanawiyah (MTs). Samples were selected purposively based on school health screening results to ensure representation of students' health conditions. Inclusion criteria included active participation in science learning, physical health, and submission of signed informed consent forms. Expert validation was conducted before product trials, involving three validators: a learning media expert, a content expert, an academic nutritionist and practitioner, and a language expert, who assessed the feasibility of the module. Following validation, the trials were carried out in two stages: a limited trial with five students to obtain initial feedback, and a broader trial with 30 students as the main respondents. The researcher was directly involved throughout development, validation, and implementation to ensure adherence to the planned procedures.

### **Instrument**

Four research instruments were used in this study. Expert validation sheets were developed based on an instrument grid covering media design, content accuracy, and language clarity, and were assessed using a 4-point Likert scale. Student response questionnaires were constructed according to indicators of readability, usability, and attractiveness using a 3-point scale. The science literacy test was developed based on a test blueprint aligned with science literacy indicators and consisted of multiple-choice and short-answer items addressing smart snack concepts, basic food microbiology, and food label literacy. Observation guidelines were prepared based on student engagement indicators during peer education activities. The science literacy test demonstrated adequate content validity through expert judgment by specialists in nutrition, biomedicine, and health promotion, and empirical item validity testing showed that all items were valid ( $p < 0.05$ ). The instrument also exhibited high internal consistency, with a Cronbach's Alpha coefficient of 0.82 across 20 items.

## Procedure

The study was conducted at MTs, Malang, over one semester (Januari–Juli 2025), involving students, teachers, and input from the local Health Office and Community Health Center. Following the ADDIE model, the procedure included analysis (identification of student health problems, needs assessment, and teacher interviews), design (module blueprint, selection of peer education and PBL methods, and storyboard preparation), development (creation of the interactive module and expert validation in media, content, and language), implementation (a limited trial with five students followed by a broader trial with 30 students), and evaluation (formative evaluation at each stage and summative evaluation after the broader trial). Data triangulation, involving comparison of observations, expert feedback, and responses from students and teachers, was applied to ensure the validity of the findings. The research procedure is illustrated in [Figure 1](#).



**Figure 1.** Flowchart of the research procedure

## Data Analysis Techniques

Data were analyzed using descriptive quantitative and qualitative approaches. Expert validation results were calculated using mean scores and categorized according to feasibility criteria. Student and teacher questionnaire responses were processed into percentages. To measure the improvement in students' scientific literacy before and after using the module, the N-Gain Score was calculated with the following categories: high ( $g \geq 0.7$ ), moderate ( $0.3 \leq g < 0.7$ ), and low ( $g < 0.3$ ) (Aripin & Mufit, 2025). Additionally, the Wilcoxon Signed Rank Test was applied to examine the significance of learning outcome improvements, considering the non-parametric characteristics of the data and the sample size.

## RESULTS AND DISCUSSION

The development model followed the ADDIE framework (Analysis, Design, Development, Implementation, and Evaluation). In the analysis stage, actual health problems at school were identified through input from the District Health Office and the Community Health Center. The Health Office reported that no specific education materials on the smart snack concept were available; the existing materials focused only on the Clean and Healthy Lifestyle (PHBS) program. Assessments from Kepanjen Community Health Center indicated incomplete hygiene facilities, unavailability of handwashing soap, limited supervision of healthy snacks, and suboptimal implementation of health promotion media and school health activities. Health education was mainly delivered through PowerPoint slides and leaflets using lecture methods in the school hall. Nutritionists at the Community Health Center emphasized that health modules specifically designed for adolescents, particularly those of a practical nature, such as Smart Snack, are still lacking. Existing resources from the Ministry of Health are largely directed toward

teachers and health workers (e.g., *Aksi Bergizi* program as facilitator guidelines), while student-focused modules remain limited. Although students already have health records, the implementation of balanced nutrition education, food label reading skills, and healthy snack selection still faces challenges. In many cases, despite exposure to healthy snack education, students continue to choose instant noodles or colored drinks due to taste preferences, peer influence, and family habits. This indicates that the family and peer environment strongly influence adolescent behavior.

Based on the needs analysis, the e-module was designed to directly target students using a simple, practical, and contextual approach. It aims to increase knowledge, foster healthy habits through direct practice and problem-based learning (PBL), strengthen peer education among adolescents, and involve teacher and parental support. The Smart Snack Strategy was developed to bridge the gap between existing formal health education and the real needs of students, thereby contributing to the prevention of nutrition-related problems, dental health issues, and risky behaviors in schools. Relevant literature used as references included the *Healthy Snack Guidelines* from BPOM, *Guidelines for School Snacks to Achieve Balanced Nutrition*, the *Healthy Snack Pocket Book*, and the *Aksi Bergizi* program. Previous studies also showed that healthy snack education effectively improves students' knowledge and attitudes; however, these interventions were generally simple (leaflets, lectures, or visual media) and not developed as structured modules. This highlights a significant gap in the availability of student-oriented modules to improve understanding and healthy snacking habits. Therefore, developing the Smart Snack Strategy module at the junior high school level is highly relevant, not only to address the lack of practical nutrition education but also to support the implementation of clean and healthy lifestyle behaviors in schools.

The design stage included three main topics: the smart snack concept, food microbiology, and food label reading (Figure 1). The smart snack concept introduces students to identifying healthy snacks, understanding adolescent energy needs, and linking food consumption with health risks such as obesity, diabetes, and malnutrition. The food microbiology component highlights the dangers of microbial contamination, characteristics of unsafe food, the importance of handwashing, and strategies for hygienic food selection. The food label reading component equips students with the ability to recognize composition, distribution permits, expiration dates, and nutritional information to make informed snack choices. The module content was structured based on field data regarding nutritional problems, dental caries, anemia, and risky snacking behaviors. The main objective was to enhance science literacy through peer education and PBL. Peer education was applied by selecting students with strong communication and leadership skills to act as change agents. These peer educators were provided with specific roles and responsibilities, including participation in training, applying knowledge in healthy snacking practices, and facilitating discussions and reflections with peers. The novelty of this module lies in its target and approach: unlike existing guidelines that are intended for teachers, health workers, or canteen managers, the Smart Snack Strategy module was designed specifically for students, combining peer education and PBL. This design not only builds knowledge but also develops practical skills, reinforces positive habits, and fosters healthy snacking behavior aligned with adolescents' daily lives.

The development stage involved expert validation by specialists in learning media, biology education, nutrition, and language. The validation results indicated that the peer educator training module on healthy snack education demonstrated a very high level of validity across all evaluated aspects. The module was considered scientifically accurate, pedagogically appropriate, and linguistically clear, with minor revisions suggested to improve competency alignment, the integration of higher-order thinking skills, conceptual clarity in food microbiology, and the inclusion of more practical examples. Following the incorporation of these revisions, the module was deemed valid and feasible for use. However, the findings were limited to expert judgment, and the absence of broader field testing suggests the need for further studies to examine its effectiveness in real classroom settings.

**Table 1.**

Expert Validation

	Aspects	Mean±SD	Score	Conclusion
Validator	Learning and media	4.83 ± 0,41	96.60	very Valid
	Content	4.10 ± 0,73	82.00	very Valid
	Language	4.50 ± 0,58	90.00	very Valid
Average		4.47	89.33	very valid

**Table 2.**  
Limited trial

	Aspects	Mean±SD	Score	Conclusion
5 students	Interface	2.40 ± 0.52	80.00	Valid
	Content	2.87 ± 0.35	95.67	very Valid
	Language	2.50 ± 0.53	83.33	very Valid
	Benefit	2.60 ± 0.52	86.67	very Valid
Average		2.59	88.45	very valid

The small-scale trial of the peer educator training module involving five students indicated that the module was considered valid across all evaluated aspects. The display, content, language, and usefulness aspects were positively evaluated, indicating that the module was well presented, easy to understand, and beneficial for learners. These results suggest that the module is suitable for use in learning activities, although further testing with a larger sample is recommended. Both language and usefulness aspects were categorized as highly valid. Overall, the trial produced an average score of 2.59 (88.45), indicating that the module is highly valid and feasible for use. Feedback from users in the small-scale trial included suggestions to add more engaging images to increase reading interest, improve image quality for clearer text, use brighter colors, and an overall appreciation that the module was already very good, with explanations that were comprehensive, detailed, and enjoyable to read.

**Table 3.**  
broader trial

	Aspect	Mean ±SD	Score	Escalation
30 students	Interface	2,20 ± 0,58	73	Valid
	Content	2,44 ± 0,52	80	Very Valid
	Language	2,33 ± 0,51	76	Valid
	Benefit	2,50 ± 0,54	83	Very Valid
Average		2,37	78	valid

The large-scale trial showed that the peer educator-based Smart Snack e-module was perceived as valid and feasible for use in learning activities. These results are in line with previous studies indicating that instructional materials developed using the ADDIE framework are generally learner-centered and suitable for classroom implementation (Branch, 2009; Abuhassna et al., 2024), and that peer-led nutrition education supports adolescents' engagement and understanding of health-related topics (Dodd et al., 2022; Ekubagewargies et al., 2025). Nevertheless, existing evidence also indicates that gains in nutrition knowledge may not consistently translate into sustained behavioral change without continued reinforcement and supportive food environments (Ares et al., 2024; Medeiros et al., 2022). Accordingly, the present results reflect the feasibility and acceptance of the Smart Snack e-module rather than long-term changes in students' dietary practices or science literacy. The measurement results are presented in Table 4.

**Table 4.** N-Gain analysis for science literacy

Aspect	Pretest Average	Posttest Average	N-Gain	Category	P Value
Smart Snack concept	69.13	98.86	0.97	High	0.001
Food Microbiology	56.00	87.20	0.69	Moderate	
Read Label	63.54	95.40	0.70	Moderate	
Average	62.98	93.81	0.79	High	

Results of the N-Gain analysis (Table 4) indicate that students' scientific literacy improved after using the Smart Snack Strategy module. The smart snack concept aspect achieved an N-Gain score of 0.97 in the high category, showing that students were able to understand the importance of choosing healthy snacks and their relationship to non-communicable disease risks. The food microbiology basics aspect achieved an N-Gain score of 0.69 in the moderate category, meaning that students' understanding of food safety and contamination hazards improved, although reinforcement is still needed in daily hygiene practices. The food label reading skills aspect scored 0.70 in the moderate category, indicating

that students became more skilled in identifying composition, distribution permits, and nutritional content in snack products. Overall, the average N-Gain of students' scientific literacy was 0.79 in the moderate–high category, suggesting that the peer education and PBL-based Smart Snack Strategy e-module effectively enhanced students' scientific literacy by 30.92 points.

The findings demonstrate that the Smart Snack Strategy e-module, developed with peer education and problem-based learning (PBL), is valid, practical, and effective in improving students' scientific literacy. High validity was achieved in media, content, and language aspects, while trial results confirmed the feasibility of the e-module. The peer education approach encouraged students to actively engage in collaborative learning with peers. This aligns with the study, which showed that Peer Led Intervention could promote healthier behaviors by increasing fruit and vegetable consumption and reducing unhealthy snack intake (Ekubagewargies et al., 2025). A review of international journals shows that school-based peer education (PE) interventions are highly effective in improving nutrition literacy compared to their moderate effectiveness in HIV prevention, health promotion, and mental health (Dodd et al., 2022). This is because PE aligns with adolescents' psychological, cognitive, and social development needs, which are rooted in functional and critical peer relationships (Ares et al., 2024). Peer education is based on the Socio-Cognitive Theory (SCT), proven effective in improving adolescent nutrition literacy over durations ranging from three weeks to one year (Medeiros et al., 2022). In this study, the intervention lasted six months (one semester), enabling a significant improvement in scientific literacy.

Peer influence plays a major role in students' decisions to choose smart snacks; however, factors such as variety, attractiveness, price, and availability of snacks are equally influential (Mesch et al., 2025). With the widespread availability of fast food, a high tendency to eat outside the home, and limited scientific literacy, students cannot often evaluate food choices based on evidence. Thus, educating students alone is insufficient—collaboration among teachers, school canteens, community health centers, and policymakers is needed to provide smart snacks within the school environment. School-based nutrition interventions have also been found effective in improving nutritional status, eating habits, healthier food choices, and overall lifestyle (Chatterjee & Nirgude, 2024)(Kim et al., 2023) (Chartejec 2024). Meanwhile, PBL plays a key role in developing scientific literacy and 21st-century skills such as critical thinking, collaboration, and communication (Aripin & Mufit, 2025) (Aripin, 2025). PBL has been shown to strengthen critical thinking, problem-solving, and the application of scientific concepts in daily life (Aripin & Mufit, 2025)(Yeyendra Yeyendra, Mellisa Mellisa, Ibnu Hajar, Sandra Puspitasari, 2024). Furthermore, socio-science-based modules have proven effective in enhancing scientific literacy in ecosystem topics (Khairrunisa et al., 2025).

Theoretical implications of this study provide evidence that integrating scientific literacy with social-cognitive (peer education) and problem-based (PBL) approaches is an effective strategy for fostering healthy habits among adolescents. The module also contributes to the development of educational media that not only imparts knowledge but also practical skills and promotes sustainable behavior. This study involved a limited number of respondents, indicating the need for wider implementation across secondary schools with the support of teachers, health professionals, and parents to establish a healthy snacking culture. Future research could expand to larger samples, long-term effectiveness tests, and measurement of impacts on real health indicators such as nutritional status, body mass index, or daily dietary habits. Moreover, integrating the module into more interactive digital platforms could strengthen its effectiveness while supporting students' digital literacy.

## CONCLUSION

The Smart Snack Strategy e-module, developed using peer education and problem-based learning (PBL), was valid, practical, and effective in improving junior high school students' scientific literacy. It enhanced students' understanding of the smart snack concept, food label reading skills, and promoted healthy consumption behaviors while fostering practical skills and positive habits. Unlike previous studies that examined peer education or PBL separately, this study demonstrates that integrating both approaches within an e-module provides a more comprehensive method for developing scientific literacy and healthy dietary practices. Practically, the module can be used by teachers, health professionals, and schools as a contextual educational tool. Future research should test the module on larger samples, evaluate long-term effects, and examine adaptability across different school settings.

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## REFERENCES

- Abuhassna, H., Alnawajha, S., Awae, F., Mohamed Adnan, M. A. Bin, & Edwards, B. I. (2024). Synthesizing technology integration within the Addie model for instructional design: A comprehensive systematic literature review. *Journal of Autonomous Intelligence*, 7(5), 1546. <https://doi.org/10.32629/jai.v7i5.1546>
- Agama, K. (2024). *Kementerian Agama Merilis Hasil Assesmen Kompetensi Madrasah 2024*.
- Ares, G., De Rosso, S., Mueller, C., Philippe, K., Pickard, A., Nicklaus, S., van Kleef, E., & Varela, P. (2024). Development of food literacy in children and adolescents: implications for the design of strategies to promote healthier and more sustainable diets. In *Nutrition Reviews* (Vol. 82, Issue 4, pp. 536–552). Oxford University Press. <https://doi.org/10.1093/nutrit/nuad072>
- Aripin, N., & Mufit, F. (2025). The Role of Problem-Based Learning in Developing Science Literacy and 21st-Century Skills in High School Students: A Meta-Analysis. *Jurnal Ilmiah Pendidikan MIPA*, 15(1), 269–284. <https://doi.org/10.30998/formatif.v15i1.27799>
- Branch, R. M. (2009). *Instructional design: The ADDIE approach*. Springer.
- BPOM. (2021). *Pedoman Pangan Jajanan Sehat Anak Sekolah (PJAS) Untuk Pencapaian Gizi Seimbang*. Badan Pengawas Obat dan makanan.
- Chatterjee, P., & Nirgude, A. (2024). A Systematic Review of School-Based Nutrition Interventions for Promoting Healthy Dietary Practices and Lifestyle Among School Children and Adolescents. *Cureus*. <https://doi.org/10.7759/cureus.53127>
- Damayanti, A. (2024). *Project-based learning e-book with Indonesian local wisdom supporting SDGs to facilitate students' bioentrepreneurship skills*. 10(3), 1002–1010. <https://doi.org/10.22219/jpbi.v10i3.36546>
- Dodd, S., Widnall, E., Russell, A. E., Curtin, E. L., Simmonds, R., Limmer, M., & Kidger, J. (2022). School-based peer education interventions to improve health: a global systematic review of effectiveness. *BMC Public Health*, 22(1). <https://doi.org/10.1186/s12889-022-14688-3>
- Ekubagewargies, D. T., Ahmed, F., & Lee, P. (2025). Effectiveness of Peer-Led Interventions in Improving the Dietary Behavior of Adolescents in Low- and Middle-Income Countries: A Systematic Review. In *Nutrition Reviews* (Vol. 83, Issue 7, pp. 1183–1197). Oxford University Press. <https://doi.org/10.1093/nutrit/nuaf037>
- Farhangi, M. A., Nikniaz, L., & Khodarahmi, M. (2020). Sugar-sweetened beverages increases the risk of hypertension among children and adolescence: A systematic review and dose-response meta-analysis. In *Journal of Translational Medicine* (Vol. 18, Issue 1). BioMed Central Ltd. <https://doi.org/10.1186/s12967-020-02511-9>
- Fatmawati, I., Pradhan, A. W., & Arini, F. A. (2020). THE ASSOCIATION BETWEEN FAST-FOOD CONSUMPTION AND PHYSICAL ACTIVITY WITH OVERWEIGHT OCCURRENCE AT SCHOOL AMONG 9-11-YEAR-OLD CHILDREN IN CAKUNG PAYANGAN BEKASI. *Jurnal Ilmu Kesehatan Masyarakat*, 11(3), 237–247. <https://doi.org/10.26553/jikm.2020.11.3.237-247>
- Ghasemi, V., Simbar, M., Fakari, F. R., Naz, M. S. G., & Kiani, Z. (2019). The effect of peer education on health promotion of iranian adolescents: A systematic review. *International Journal of Pediatrics*, 7(3), 9139–9157. <https://doi.org/10.22038/ijp.2018.36143.3153>
- Grimes, C. A., Bolton, K. A., Booth, A. B., Khokhar, D., Service, C., He, F. H., & Nowson, C. A. (2021). The association between dietary sodium intake, adiposity and sugar-sweetened beverages in children and adults: A systematic review and meta-analysis. In *British Journal of Nutrition* (Vol. 126, Issue 3, pp. 409–427). Cambridge University Press. <https://doi.org/10.1017/S0007114520004122>
- He, F. J., Marrero, N. M., & MacGregor, G. A. (2008). Salt intake is related to soft drink consumption in children and adolescents: A link to obesity? *Hypertension*, 51(3), 629–634.

<https://doi.org/10.1161/HYPERTENSIONAHA.107.100990>

- Hidayati NL dan Rachmadiarti. (2024). Pengebangan E-LKPD Berbasis PBL Sub Materi Pencemaran Lingkungan Untuk Melatih Keterampilan Literasi SAINS ( MEendukung SDGS Poin 6 dan 13 ). *BioEdu*, 13(3), 717–724. <https://doi.org/10.26740/bioedu.v13n3.p717-724>
- IHME (Institute for Health Metrics and Evaluation). (2023). *Noncommunicable diseases*. Institute for Health Metrics and Evaluation.
- Jia, M. M., Wang, C., Zhang, Y., Zheng, Y., Zhang, L., Huang, Y., & Wang, P. (2012). Sugary beverage intakes and obesity prevalence among junior high school students in Beijing—a cross-sectional research on SSBs intake. In *Asia Pac J Clin Nutr* (Vol. 21, Issue 3).
- Jumiyati, Lisma Ningsih, M. H. (2019). FAST FOOD CONTRIBUTION TOWARD OBESITY IN THE STUDENTS OF JUNIOR HIGH SCHOOL. *International Conference on Inter-Professional Health Collaboration*.
- Kesehatan, B. K. P. (2023). *Survei Kesehatan Indonesia 2023*.
- Khairrunisa, A. N., Yusup, I. R., & Paujiah, E. (2025). Improving students' scientific literacy through a problem-based learning model integrated with socio-scientific issues on ecosystem learning. *Biosfer*, 18(2), 276–289. <https://doi.org/10.21009/biosferjpb.55744>
- Kim, S. S., Sununtnasuk, C., Berhane, H. Y., Walissa, T. T., Oumer, A. A., Asrat, Y. T., Sanghvi, T., Frongillo, E. A., & Menon, P. (2023). Feasibility and impact of school-based nutrition education interventions on the diets of adolescent girls in Ethiopia: a non-masked, cluster-randomised, controlled trial. *The Lancet Child and Adolescent Health*, 7(10), 686–696. [https://doi.org/10.1016/S2352-4642\(23\)00168-2](https://doi.org/10.1016/S2352-4642(23)00168-2)
- Mancone, S., Corrado, S., Tosti, B., Spica, G., & Diotaiuti, P. (2024). Integrating digital and interactive approaches in adolescent health literacy: a comprehensive review. In *Frontiers in Public Health* (Vol. 12). Frontiers Media SA. <https://doi.org/10.3389/fpubh.2024.1387874>
- Medeiros, G. C. B. S. de, Azevedo, K. P. M. de, Garcia, D., Oliveira Segundo, V. H., Mata, Á. N. de S., Fernandes, A. K. P., Santos, R. P. dos, Trindade, D. D. B. de B., Moreno, I. M., Guillén Martínez, D., & Piuvezam, G. (2022). Effect of School-Based Food and Nutrition Education Interventions on the Food Consumption of Adolescents: A Systematic Review and Meta-Analysis. In *International Journal of Environmental Research and Public Health* (Vol. 19, Issue 17). MDPI. <https://doi.org/10.3390/ijerph191710522>
- Mesch, A., Hoefnagels, F., Gulikers, J., Wesselink, R., Winkens, L. H. H., Raghoobar, S., & Haveman-Nies, A. (2025). The food environment through the eyes of adolescents: exploring socioecological factors and opportunities for healthy and sustainable food choices. *BMC Public Health*, 25(1). <https://doi.org/10.1186/s12889-025-23441-5>
- Min, J. E., Green, D. B., & Kim, L. (2017). Calories and sugars in boba milk tea: implications for obesity risk in Asian Pacific Islanders. *Food Science and Nutrition*, 5(1), 38–45. <https://doi.org/10.1002/fsn3.362>
- Novelasari, & Hayati, N. F. (2022). Buku Saku Jajanan Sehat Anak Sekolah. *Politeknik Kesehatan Kemenkes RI Padang*, 21.
- OECD 2023. (2022). PISA PISA 2022 Results Malaysia. *Journal Pendidikan*, 10.
- Schneider, S., Schilling, L., & Osenbrügge, N. (2021). DETERMINANTS OF SOFT DRINK CONSUMPTION AMONG CHILDREN AND ADOLESCENTS IN DEVELOPED COUNTRIES – A SYSTEMATIC REVIEW. In *Central European Journal of Public Health* (Vol. 29, Issue 4, pp. 290–300). Czech National Institute of Public Health. <https://doi.org/10.21101/cejph.a6755>
- Setiawan, I. (2022). Pembelajaran Berbasis Problem Based Learning (Pbl) Dalam Meningkatkan Keterampilan Berpikir Kritis Di. *Jurnal Sains Edukatika Indonesia (JSEI)*, 4(1), 12–16. <https://jurnal.uns.ac.id/jsei/article/view/70929/39316>
- Shanka Resia, A., Dwi Jayanti Pamungkas, P., & Fauzi Rachman, I. (2024). *Building a Digital Future: Tasikmalaya Youth Literacy Innovation and Sdgs 2030* 1. 2, 366–376. <https://indopediajurnal.my.id/index.php/jurnal/article/view/295/199>
- Yeyendra Yeyendra, Mellisa Mellisa, Ibnu Hajar, Sandra Puspitasari, R. S. (2024). Model Online Problem Based Learning (e-PBL) Terintegrasi Etnoekologi untuk Meningkatkan Literasi Lingkungan Mahasiswa Pendidikan Biologi \*Yeyendra. *Asatiza Jurnal Pendidikan*, 5(1), 61–68. <https://doi.org/10.46963/asatiza.v5i1.1690>