OPEN ACCESS
Journal of World Future Medicine, Health and Nursing
Vol. 4 No. 4. August 2026, pp. 539-551
Check for updates
DOI. 10.70177/health.v4i4.4291
Research Article

CHANGES IN KNOWLEDGE AND ATTITUDES FOLLOWING EXPERIENTIAL NUTRITION EDUCATION WITH VEGETABLE NUGGETS: A TWO-SCHOOL QUASI-EXPERIMENT

Sri Sunarti[1], Fitriyani A[2], Dwi Wulan Indriani[3], Hikmal Raihansyah[4], Nuralifah Amalia Ishmah[5], Reyhana Damara Pradatya[6]
[1]Universitas Muhammadiyah Kalimantan Timur, Indonesia
[2]Universitas Muhammadiyah Kalimantan Timur, Indonesia
[3]Universitas Muhammadiyah Kalimantan Timur, Indonesia
[4]Universitas Muhammadiyah Kalimantan Timur, Indonesia
[5]Universitas Muhammadiyah Kalimantan Timur, Indonesia
[6]Universitas Muhammadiyah Kalimantan Timur, Indonesia

Corresponding Author:

Sri Sunarti,
Universitas Muhammadiyah Kalimantan Timur, Indonesia
Jl. Ir. H. Juanda No.15, Sidodadi, Kec. Samarinda Ulu, Kota Samarinda, Kalimantan Timur 75124
Email: srisunarti@umkt.ac.id

Article Info

Received: February 07, 2026
Revised: May 11, 2026
Accepted: June 12, 2026
Online Version: August 23, 2026

Abstract

Low vegetable intake among Indonesian schoolchildren persists, yet evidence on interventions pairing classroom education with a familiar vegetable-based food remains limited. This study assessed changes in knowledge and attitudes following experiential nutrition education combined with vegetable nugget provision. A quasi-experimental pretest-posttest nonequivalent control-group study included 164 second-grade students selected by simple random sampling within two elementary schools in East Kalimantan, Indonesia (82 per group). For 14 days, the intervention group received nutrition education and vegetable nuggets, while the control group continued usual activities. Baseline knowledge and attitude distributions differed significantly ($p < 0.001$). Knowledge changed in both groups ($p < 0.001$), although the control group mainly shifted from poor to moderate. Attitudes changed in the intervention group ($p < 0.001$) but not the control group ($p = 0.276$). Improvement was more frequent in the intervention group for knowledge (51.2% vs. 26.8%; exact $p = 0.001$) and attitudes (92.7% vs. 22.0%; $p < 0.001$).

Keywords: Food Preferences, Nutrition Education, School Health

Journal Homepage	https://research.adra.ac.id/index.php/health ISSN: (P: 2988-7550) - (E: 2988-0459)
How to cite:	Sunarti, S., A, F., Indriani, W, D., Raihansyah, H., Ishamah, H, N & Pradayta, D, R (2026). Changes in Knowledge and Attitudes Following Experiential Nutrition Education with Vegetable Nuggets: A Two-School Quasi-Experiment. *Journal of World Future Medicine, Health and Nursing, 4*(4), 539–551. https://doi.org/10.70177/health.v4i4.4291
Published by:	Yayasan Adra Karima Hubbi

INTRODUCTION

Vegetables are an essential component of a healthy diet because they provide fiber, vitamins, minerals, and various bioactive compounds required for growth and health maintenance. The World Health Organization recommends a daily fruit and vegetable intake of at least 350 g for children aged 6–9 years and 400 g for individuals aged 10 years or older (World Health Organization, 2023). Nevertheless, fruit and vegetable consumption in Indonesia remains very low. The 2023 Indonesian Health Survey reported that 96.7% of people aged five years or older did not meet the recommended fruit and vegetable intake, while 67.5% consumed only one to two servings per day (Health Development Policy Agency, 2024). These findings underscore the need for interventions beginning at school age to foster knowledge and positive attitudes toward vegetable consumption.

Elementary school is a critical period for developing food preferences and eating habits. Nutrition knowledge enables children to recognize the benefits of vegetables and understand healthy food choices, whereas attitudes reflect their acceptance, evaluation, and inclination to choose vegetables. Knowledge and attitudes are not equivalent to actual consumption behavior, but both are proximal determinants of food choice. Schools provide a strategic setting because they can reach children systematically, create a supportive learning environment, and integrate health messages into everyday experiences (Saha et al., 2020; Hahnraths et al., 2022). Nutrition education should therefore be appropriate to children's cognitive development and extend beyond one-way information delivery.

School-based nutrition education can improve determinants of fruit and vegetable intake, including knowledge and behavioral factors related to consumption (Saha et al., 2020; Hahnraths et al., 2022). Recent research increasingly favors multicomponent and experiential approaches rather than one-way information delivery. Curricula paired with tasting, repeated food exposure, gardening, cooking, or produce provision are being used to address knowledge, preferences, attitudes, and intentions simultaneously (Poelman et al., 2020; Verdonschot et al., 2023; van Lier et al., 2024; Liao et al., 2025). This trend shifts the focus from information transfer alone toward learning reinforced by concrete food experiences. Intervention components, intensity, duration, and delivery methods nevertheless remain important determinants of outcomes (Verdonschot et al., 2023).

Direct food experiences can complement nutrition education because strategies that expose children to vegetables may enhance both knowledge and acceptance. Experiential nutrition learning that combines classroom activities, food identification, cooking, and shared meals may also produce longer-term benefits for children's attitudes (Braga-Pontes et al., 2022; van Lier et al., 2024). School programs integrating gardening, cooking, and education have increased vegetable intake (Davis et al., 2021), while hands-on food preparation and tasting have improved children's willingness to consume vegetables (Melnick et al., 2020). Nutrition information reinforced through concrete experiences may therefore be easier for children to understand and apply.

In Indonesia, various health education media have been developed to improve children's knowledge and attitudes regarding fruit and vegetable consumption. Interactive health education can improve knowledge, attitudes, parental support, and fruit and vegetable intake among elementary schoolchildren (Puspita et al., 2024). However, most interventions continue to focus on educational media such as books, leaflets, games, or counseling sessions. Evidence remains limited regarding interventions that combine nutrition education with a child-familiar vegetable-based food product, particularly vegetable nuggets. In this study, vegetable nuggets were used as a direct experiential component complementing nutrition education rather than as the sole cause of change. Studies combining nutrition education with vegetable nugget provision among Indonesian elementary schoolchildren remain scarce (Braga-Pontes et al., 2022; Hahnraths et al., 2022; Puspita et al., 2024).

The novelty of this study lies in combining age-appropriate nutrition education with 14 days of exposure to vegetable nuggets as a concrete, child-familiar learning medium. Unlike interventions relying solely on educational media, this approach links cognitive information with a direct food experience. Its conceptual contribution is to examine whether this connection is accompanied by more favorable changes in knowledge and attitudes, consistent with experiential and repeated-exposure approaches to school nutrition education. The study involved second-grade students from two elementary schools, with one school assigned to each study group. It focused on knowledge and attitudes and did not assess actual consumption or nutritional status. Accordingly, this study aimed to assess changes in knowledge and attitudes toward vegetable consumption and to compare patterns of change between the intervention and control groups.

RESEARCH METHOD

This study employed a quasi-experimental pretest-posttest nonequivalent control-group design in two elementary schools, with one school serving as the intervention group and the other as the control group.

Research Design

The design was selected because random allocation of individual students across schools was not feasible, whereas prospective measurement with a concurrent comparison group offered better control of temporal and repeated-testing effects than a cross-sectional or single-group pretest-posttest design. Assigning separate schools also reduced contamination of intervention information and activities between groups. A cluster-randomized design would provide stronger causal inference; therefore, the selected design represented the most appropriate feasible approach rather than an equivalent substitute for randomization.

Knowledge and attitudes were measured before the intervention and after the 14-day intervention period. The intervention group received nutrition education and vegetable nuggets, whereas the control group continued its usual school activities and received neither nutrition education nor vegetable nuggets from the research team during the study period.

Research Target/Subject

The study population comprised all second-grade students at the two participating elementary schools. The sample consisted of 164 students, with 82 in the intervention group and 82 in the control group. The sample size was calculated using the Lemeshow formula for a finite population, assuming a proportion of 50% ($P = 0.50$) and a margin of error of 10% ($d = 0.10$).

Eligible students at each school were selected by simple random sampling from the second-grade enrollment list. Each student was assigned a number, and numbers were randomly selected until the required sample size for each group was reached. Random sampling was conducted at the student level within each school, not for school selection or group allocation.

The inclusion criteria were active enrollment in the second grade, written parental or guardian consent, willingness to participate, and completion of both pretest and posttest measurements. Students who did not complete all measurement procedures or had a condition preventing them from consuming vegetable nuggets were excluded from the analysis. A history of allergy to any nugget ingredient was screened before the intervention. All 164 students completed the pretest and posttest assessments; therefore, no knowledge or attitude data were missing.

Research Procedure

Preparation, The researchers coordinated with the participating schools, designated the study groups, screened students against the eligibility criteria, obtained school authorization, and prepared the educational materials, questionnaires, and vegetable nuggets. Data collectors were briefed on the intervention and questionnaire-administration procedures.

Pretest, Before the intervention, students in both groups completed questionnaires assessing knowledge of and attitudes toward vegetable consumption. Standardized procedures were used in both groups. Enumerators assisted students in understanding the questions without directing their responses.

Intervention, The intervention group received nutrition education and vegetable nuggets over a 14-day period. Educational content covered the definition and varieties of vegetables, the benefits and recommended intake of vegetables, and strategies for developing regular vegetable-consumption habits. The education was delivered through a slide presentation on the benefits of fruits and vegetables and lasted approximately 15 minutes. Five vegetable nuggets were provided in paper packaging bearing nutritional information. Students also received take-home information for their parents describing the nutritional benefits and preparation of the nuggets.

Before implementation, the vegetable nugget formulation was reviewed by nutritionists at a professional meeting in Samarinda. Based on their feedback, spinach leaves were replaced with katuk leaves (Sauropus androgynus), which were considered nutritionally comparable but more resistant to heat during processing.

The control group received neither nutrition education nor vegetable nuggets from the research team and continued its usual school activities. After the posttest had been completed, the control group received the nutrition education; however, knowledge and attitudes were not reassessed after this delayed education.

Posttest, After the 14-day intervention period, students in both groups again completed the knowledge and attitude questionnaires using the same instruments and procedures as at pretest.

Instruments and Data Collection Techniques

The study data included participant characteristics, knowledge of vegetable consumption, and attitudes toward vegetable consumption. Data were collected using a structured questionnaire administered before and after the intervention.

The knowledge questionnaire comprised 10 dichotomous items on balanced nutrition, including carbohydrates, protein, and physical activity, with response options of “yes” and “no.” Each correct response was scored 1 and each incorrect response 0. Total scores were categorized as good (>80%), moderate (60%–80%), or poor (<60%). The attitude questionnaire comprised 10 dichotomous statements on balanced nutrition—five positively worded and five negatively worded—with response options of “agree” and “disagree.” Each appropriate response was scored 1 and each inappropriate response 0. Attitude scores were categorized using the same thresholds: good (>80%), moderate (60%–80%), and poor (<60%).

The questionnaires were pilot-tested for validity among 30 students at SD Muhammadiyah 2 Samarinda who were not included in the main study. This school was selected because it had an accreditation status comparable to that of SD Muhammadiyah 4 and because the school provided access and institutional support for instrument testing. Item validity was assessed using Pearson's correlation coefficient. With 30 respondents, a 5% significance level, and degrees of freedom calculated as $df = N - 2$, the critical r value was 0.361. All 10 knowledge items and all 10 attitude items had calculated r values greater than 0.361 and were therefore considered valid.

Internal consistency was evaluated using Cronbach's alpha, with a coefficient greater than 0.60 considered acceptable. Cronbach's alpha was 0.731 for the knowledge scale and 0.718 for the attitude scale. Because both coefficients exceeded 0.60, the knowledge and attitude questionnaires were considered reliable.

Data Analysis Technique

Data were analyzed using IBM SPSS Statistics version 23. Univariate analysis summarized the distributions of knowledge and attitude categories as frequencies and percentages. Within each group, changes in knowledge and attitude categories from pretest to posttest were examined using the Stuart–Maxwell test. This test was selected because the measurements were paired and the outcomes comprised more than two nominal categories. Analyses were performed separately for the intervention and control groups.

Differences in the distributions of knowledge and attitude categories between the intervention and control groups at pretest and posttest were assessed using Pearson's chi-square test. When any expected cell frequency was below five, the Fisher–Freeman–Halton exact test was used.

For each participant, category change was determined by comparing the posttest category with the pretest category and classifying the result as decreased, unchanged, or increased. The distribution of these change categories was compared between groups using Pearson's chi-square test or, when chi-square assumptions were not met, the Fisher–Freeman–Halton exact test.

All tests were two-sided, with a significance level of 5%. A p value < 0.05 was considered statistically significant. Because the pretest distributions of knowledge and attitudes differed significantly between groups, the findings were interpreted cautiously in light of this baseline imbalance.

Ethical Approval

The study received ethical approval from the relevant research ethics committee (No. 04/KEPK-STIKES-MM/I/2025). Parents or guardians provided written informed consent, and students received age-appropriate study information and provided assent. Participant identities were kept confidential, and data were used solely for research purposes.

RESULTS AND DISCUSSION

Participant characteristics, including class level, age, and sex, are presented in Table 1. The distribution of participants across these demographic characteristics provides an overview of the composition of the study sample and helps contextualize the subsequent analysis. Class level indicates the participants’ educational stage, while age reflects their developmental characteristics. Sex is also included to describe the demographic composition of the sample. These characteristics are important for identifying the overall profile of the participants and assessing the representativeness of the sample in relation to the objectives of the study. Participant characteristics, including class, age, and sex, are presented in Table 1.

Table 1. Frequency distribution of participants by class, age, and sex

Characteristic	Intervention group			Control group	
	Frequency (n)	Percentage (%)		Frequency (n)	Percentage (%)
Class 2.1	22	26.8	Class Al-Aziz	26	31.7
2.2	19	23.2	Al-Muhaimin	28	34.1
2.3	22	26.8	Al-Jabbarr	28	34.1
2.4	19	23.2			
Age (years)			Age (years)		
7	16	19.5	7	16	19.5
8	60	73.2	8	64	78.0
9	5	6.1	9	2	2.4
10	1	1.2			
Sex			Sex		
Male	37	45.1	Male	43	52.4
Female	45	54.9	Female	39	47.6
Total	82	100		82	100

In the intervention group, the largest class groups were classes 2.1 and 2.3 (26.8% each); in the control group, Al-Muhaimin and Al-Jabbarr were the largest classes (34.1% each). Most students in both groups were 8 years old (intervention: 73.2%; control: 78.0%). The least represented age was 10 years in the intervention group (1.2%) and 9 years in the control group (2.4%). Girls constituted a larger proportion of the intervention group (54.9%), whereas boys constituted a larger proportion of the control group (52.4%).

A total of 164 students completed all study procedures, including 82 in the intervention group and 82 in the control group. There were no missing data for the knowledge and attitude variables. Outcomes were classified as poor, moderate, or good. Changes in Knowledge of Vegetable Consumption

Table 2. Distribution of knowledge categories in the intervention and control groups

Measurement	Group	Poor, n (%)	Moderate, n (%)	Good, n (%)
Pretest	Intervention	8 (9.8)	73 (89.0)	1 (1.2)
	Control	63 (76.8)	19 (23.2)	0 (0.0)
Posttest	Intervention	0 (0.0)	45 (54.9)	37 (45.1)
	Control	45 (54.9)	37 (45.1)	0 (0.0)

At pretest, most students in the intervention group had moderate knowledge (89.0%), whereas the control group was predominantly in the poor category (76.8%). At posttest, no student in the intervention group remained in the poor category: 37 students (45.1%) achieved good knowledge and 45 (54.9%) had moderate knowledge. In the control group, no student achieved good knowledge; 45 students (54.9%) remained in the poor category and 37 (45.1%) had moderate knowledge.

The observed improvement in knowledge is consistent with evidence that school-based nutrition education using combined strategies can improve knowledge and factors related to fruit and vegetable consumption (Saha et al., 2020; Antwi et al., 2020; Mogre et al., 2024). Evidence-based nutrition interventions have also improved nutrition-related knowledge and behaviors

(Oddo et al., 2022). School nutrition education tends to produce better outcomes when it incorporates active learning and direct experience (Cotton et al., 2020; Verdonschot et al., 2023).

Nutrition education provides a cognitive foundation that helps students identify the benefits, varieties, and importance of vegetable consumption. Vegetable nuggets may provide a concrete experience linking information with food that children can see, taste, and consume. Learning that combines explanation with direct experience may be more accessible to children than verbal information alone (Jarpe-Ratner et al., 2016; Scherr et al., 2021).

The change in knowledge observed in the control group should be interpreted cautiously. It may reflect a repeated-measurement effect, exposure to nutrition information through routine school lessons or other sources, communication between students, or baseline differences. These factors were not measured and therefore cannot be confirmed as explanations for the control group's change. Changes in Attitudes Toward Vegetable Consumption:

Table 3. Distribution of attitude categories in the intervention and control groups

Measurement	Group	Poor, n (%)	Moderate, n (%)	Good, n (%)
Pretest	Intervention	4 (4.9)	78 (95.1)	0 (0.0)
	Control	50 (61.0)	32 (39.0)	0 (0.0)
Posttest	Intervention	0 (0.0)	6 (7.3)	76 (92.7)
	Control	44 (53.7)	36 (43.9)	2 (2.4)

Data are presented as frequency (percentage).

At pretest, no student in either group had an attitude categorized as good. The intervention group was predominantly in the moderate category (95.1%), whereas the control group was predominantly in the poor category (61.0%). After the intervention, 76 students in the intervention group (92.7%) achieved a good attitude and none remained in the poor category. In the control group, only two students (2.4%) achieved a good attitude, while 44 (53.7%) remained in the poor category.

The magnitude of the attitude change may be related to the combined approach. Education provided an understanding of vegetable consumption, while the vegetable nuggets enabled children to experience a familiar vegetable-based product directly. Classroom nutrition education combined with fruit and vegetable taste testing has been reported to improve children's dietary intake (Gold et al., 2017). Experiential vegetable education has also improved knowledge, acceptance, intention to consume, and willingness to try vegetables (Poelman et al., 2020).

Activities engaging the senses and providing direct experience may reduce unfamiliarity with vegetable-based foods. Sensory-based food education has been associated with greater willingness among children to choose and consume vegetables, fruits, and berries (Kähkönen et al., 2018). Child-friendly educational strategies may likewise improve knowledge and acceptance of vegetables (Braga-Pontes et al., 2022).

The attitude changes are also consistent with findings from a school program that combined nutrition education with fruit and vegetable provision (Liao et al., 2025). Gardening, cooking, and nutrition education programs, as well as hands-on food preparation and tasting, indicate that education paired with practical activities can improve vegetable acceptance and consumption (Melnick et al., 2020; Davis et al., 2021).

Repeated exposure is one possible mechanism underlying the change. Taste exposure may increase intake and willingness to try vegetables (Appleton et al., 2018; Nekitsing et al., 2019), and repeated exposures at varying frequencies may increase children's liking and acceptance of unfamiliar vegetables. However, this study did not directly measure liking, the number of nuggets consumed, or sensory acceptance; therefore, this mechanism requires further investigation (Karagiannaki et al., 2021). Within-Group Changes:

Table 4. Stuart–Maxwell test results for knowledge and attitudes

Variable	Group	Stuart–Maxwell statistic	p value
Knowledge	Intervention	40.563	<0.001
Knowledge	Control	12.462	<0.001
Attitude	Intervention	76.000	<0.001
Attitude	Control	2.571	0.276

The Stuart–Maxwell test compared paired category distributions between pretest and posttest within each group.

Knowledge distributions changed significantly in both groups, but a significant change in attitudes occurred only in the intervention group. The stronger attitude change may be related to the combination of information and direct experience. Nevertheless, the high proportion of students with good posttest attitudes represents a psychosocial outcome and should not be interpreted as evidence of increased habitual vegetable consumption.

Knowledge and attitudes are important determinants of eating behavior, but they do not necessarily translate directly into actual intake. Combining intervention strategies may change fruit and vegetable preferences, although behavioral effects continue to depend on intervention duration and design (Ilić et al., 2023). Knowledge, attitudes, intentions, food availability, and school and family environments interact in shaping consumption (Hahnraths et al., 2022; Oddo et al., 2022).

School-based food and nutrition education interventions generally yield positive outcomes, but the magnitude of change depends on their components, intensity, delivery agents, and implementation environment. Strategies combining information with positive food experiences may therefore be more promising than information delivery alone (Cotton et al., 2020; Verdonschot et al., 2023). Comparison of the Magnitude of Change Between Groups

Table 5. Comparison of changes in knowledge and attitude categories between groups

Variable	Change	Intervention, n (%)	Control, n (%)
Knowledge	Decreased	0 (0.0)	4 (4.9)
	Unchanged	40 (48.8)	56 (68.3)
	Increased	42 (51.2)	22 (26.8)
Attitude	Decreased	0 (0.0)	12 (14.6)
	Unchanged	6 (7.3)	52 (63.4)
	Increased	76 (92.7)	18 (22.0)

Knowledge: Fisher–Freeman–Halton exact $p = 0.001$. Attitude: Pearson $\chi^2 = 84.270$; $df = 2$; $p < 0.001$.

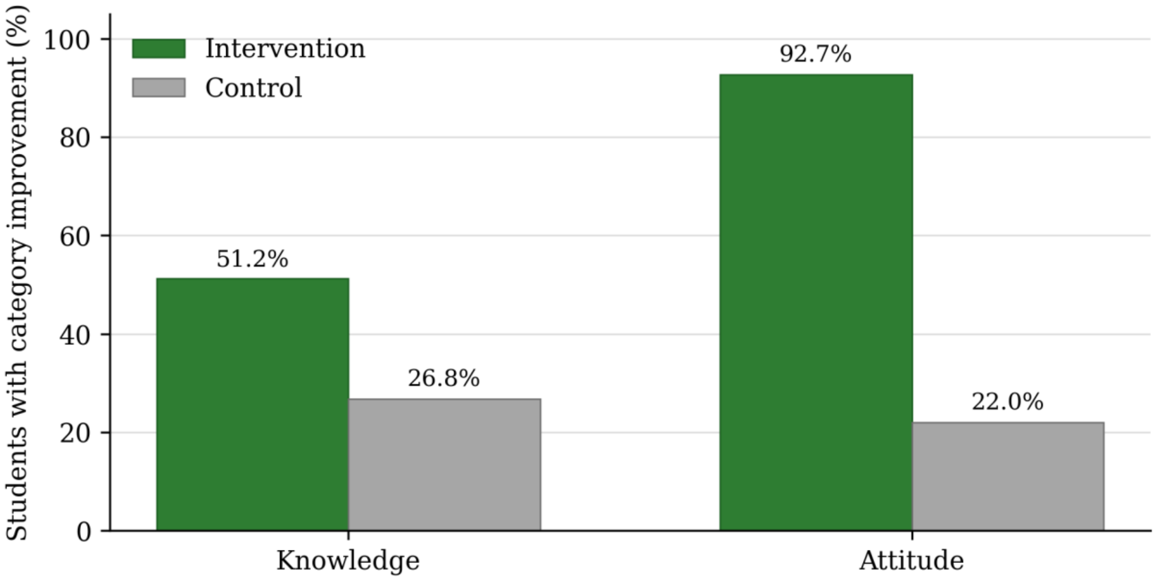

Figure 1. Proportion of students whose outcome category increased from pretest to posttest

Knowledge category improvement occurred in 51.2% of students in the intervention group and 26.8% of those in the control group. Because some expected frequencies were small, the Fisher–Freeman–Halton exact test was used as the primary result and indicated a significant difference (exact $p = 0.001$). Pearson's chi-square test yielded $\chi^2 = 12.917$, df = 2, and $p = 0.002$, with Cramer's V = 0.281, indicating a moderate association between study group and change in knowledge category.

Attitude category improvement occurred in 92.7% of students in the intervention group and 22.0% of those in the control group. The difference was significant ($\chi^2 = 84.270$; df = 2; $p < 0.001$), with Cramer's V = 0.717, indicating a strong association between study group and change in attitude category.

From a school-health perspective, the between-group differences were not only statistically significant but also programmatically meaningful: improvement was 24.4 percentage points higher for knowledge and 70.7 percentage points higher for attitudes in the intervention group. Comparable multicomponent initiatives provide contextual support. The Texas Sprouts cluster trial combined gardening, cooking, and nutrition education and increased vegetable intake (Davis et al., 2021), whereas a Palau pilot combining nutrition education with fruit and vegetable provision reported improved consumption (Liao et al., 2025). Together with experiential education findings (Poelman et al., 2020), these studies support pairing information with repeated, practical exposure. In schools, this could involve brief age-appropriate lessons, tasting opportunities, teacher reinforcement, and take-home information for parents. Vegetable nuggets should be presented as an educational tasting vehicle, not as a nutritional substitute for whole vegetables.

Conceptually, the observed pattern supports the proposition that cognitive information reinforced by direct sensory experience may produce more favorable psychosocial outcomes than information alone. The intervention's practical novelty was the use of vegetable nuggets as a familiar food format through which students could connect nutrition messages with direct exposure. However, the design did not include separate education-only and nugget-only groups.

The contribution of each component therefore cannot be isolated, and the findings can be attributed only to the combined intervention.

Causal interpretation is limited by the significant baseline imbalance. Before the intervention, the intervention group already had more favorable distributions of knowledge and attitudes than the control group. Furthermore, only two schools participated, with one school representing each group. The intervention effect cannot be fully separated from differences in school characteristics, teaching quality, food environments, teacher support, and family circumstances.

Because the study measured only knowledge and attitudes, it cannot conclude that students' vegetable consumption increased. Vegetable nuggets are vegetable-based processed foods and are not equivalent to consuming whole vegetables. Future studies should assess consumption frequency and portion size, liking, willingness to try, plate waste, sensory acceptance, and vegetable availability at home and school.

Future research should involve more schools with school-level randomization and include education-only, product-only, combined-intervention, and control groups. Ordinal regression or generalized estimating equations controlling for baseline values are also warranted. Follow-up measurements at one to six months would help determine whether changes are sustained.

CONCLUSION

The 14-day combined intervention of nutrition education and vegetable nugget provision was associated with improved knowledge and attitudes toward vegetable consumption among second-grade elementary school students. Knowledge category improvement was more frequent in the intervention group than in the control group (51.2% vs. 26.8%; exact $p = 0.001$), as was attitude category improvement (92.7% vs. 22.0%; $p < 0.001$). The Stuart-Maxwell test showed significant changes in intervention-group knowledge and attitudes (both $p < 0.001$); control-group knowledge also changed, but attitudes did not ($p = 0.276$). This pattern is consistent with experiential and multicomponent school nutrition studies pairing education with tasting, gardening, cooking, or produce provision (Poelman et al., 2020; Davis et al., 2021; Liao et al., 2025). If reinforced over time, the approach may contribute to durable food literacy and more favorable vegetable preferences. However, baseline imbalance, one school per group, and the absence of consumption and follow-up measures limit causal and long-term conclusions.

DECLARATION OF AI AND AI ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During preparation of this manuscript, the authors used Grammarly to assist with English-language editing and to improve clarity, readability, and organization. After using this tool, the authors reviewed, verified, and revised all suggested material. The authors take full responsibility for the accuracy, integrity, and content of the article.

ACKNOWLEDGMENTS

The authors thank the Bachelor of Public Health Program, Faculty of Public Health, Universitas Muhammadiyah Kalimantan Timur, for its permission and support throughout the research process. The authors also thank SD Muhammadiyah 4 Terpadu Samarinda, SD Muhammadiyah 2 Samarinda, and SD Muhammadiyah 1 Tenggarong, East Kalimantan Province, for supporting instrument validity and reliability testing, granting research permission, and facilitating study implementation.

AUTHOR CONTRIBUTIONS

Author 1: Conceptualization, methodology, project administration.
Author 2: Methodology, investigation, data curation, formal analysis, and writing original draft.
Author 3: Methodology, validation, formal analysis, and writing review and editing.
Author 4: Investigation, intervention delivery, data collection, and data curation.
Author 5: Investigation, intervention delivery, data collection, and project administration.
Author 6: Investigation, intervention delivery, data collection, and data entry.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no known financial interests, personal relationships, or other conflicts of interest that could have influenced the research or the findings reported in this article.

REFERENCES

Antwi, J., Ohemeng, A., Boateng, L., Quaidoo, E., & Bannerman, B. (2020). Primary school-based nutrition education intervention on nutrition knowledge, attitude and practices among school-age children in Ghana. *Global Health Promotion, 27*(4), 114–122. https://doi.org/10.1177/1757975920945241

Appleton, K. M., Hemingway, A., Rajska, J., & Hartwell, H. (2018). Repeated exposure and conditioning strategies for increasing vegetable liking and intake: Systematic review and meta-analyses of the published literature. *The American Journal of Clinical Nutrition, 108*(4), 842–856. https://doi.org/10.1093/ajcn/nqy143

Health Development Policy Agency. (2024). Survei Kesehatan Indonesia (SKI) 2023 dalam angka [2023 Indonesian Health Survey in figures]. Ministry of Health of the Republic of Indonesia. https://www.badankebijakan.kemkes.go.id/repositori/id/eprint/5539/

Braga-Pontes, C., Simões-Dias, S., Lages, M., Guarino, M. P., & Graça, P. (2022). Nutrition education strategies to promote vegetable consumption in preschool children: The Veggies4myHeart project. *Public Health Nutrition, 25*(4), 1061–1070. https://doi.org/10.1017/S1368980021004456

Cotton, W., Dudley, D., Peralta, L., & Werkhoven, T. (2020). The effect of teacher-delivered nutrition education programs on elementary-aged students: An updated systematic review and meta-analysis. *Preventive Medicine Reports, 20*, 101178. https://doi.org/10.1016/j.pmedr.2020.101178

Davis, J. N., Pérez, A., Asigbee, F. M., Landry, M. J., Vandyousefi, S., Ghaddar, R., Hoover, A., Jeans, M., Nikah, K., Fischer, B., Pont, S. J., Richards, D., Hoelscher, D. M., & Van Den Berg, A. E. (2021). School-based gardening, cooking and nutrition intervention increased vegetable intake but did not reduce BMI: Texas Sprouts—A cluster randomized controlled trial. *International Journal of Behavioral Nutrition and Physical Activity, 18*(1), 18. https://doi.org/10.1186/s12966-021-01087-x

Gold, A., Larson, M., Tucker, J., & Strang, M. (2017). Classroom nutrition education combined with fruit and vegetable taste testing improves children's dietary intake. *Journal of School Health, 87*(2), 106–113. https://doi.org/10.1111/josh.12478

Hahnraths, M. T. H., Jansen, J. P. M., Winkens, B., & van Schayck, O. C. P. (2022). The effects of a multi-component school-based nutrition education intervention on children's determinants of fruit and vegetable intake. *Nutrients, 14*(20), 4259. https://doi.org/10.3390/nu14204259

Ilić, A., Rumbak, I., Brečić, R., Colić Barić, I., & Bituh, M. (2023). Three-year school-based multicomponent intervention may change fruit and vegetable preferences in primary school children—A quasi-randomized trial. *Nutrients, 15*(16), 3505. https://doi.org/10.3390/nu15163505

Jarpe-Ratner, E., Folkens, S., Sharma, S., Daro, D., & Edens, N. K. (2016). An experiential cooking and nutrition education program increases cooking self-efficacy and vegetable consumption in children in grades 3–8. *Journal of Nutrition Education and Behavior, 48*(10), 697–705.e1. https://doi.org/10.1016/j.jneb.2016.07.021

Kähkönen, K., Rönkä, A., Hujo, M., Lyytikäinen, A., & Nuutinen, O. (2018). Sensory-based food education in early childhood education and care, willingness to choose and eat fruit and vegetables, and the moderating role of maternal education and food neophobia. *Public Health Nutrition, 21*(13), 2443–2453. https://doi.org/10.1017/S1368980018001106

Karagiannaki, K., Ritz, C., Jensen, L. G. H., Tørsleff, E. H., Møller, P., Hausner, H., & Olsen, A. (2021). Optimising repeated exposure: Determining optimal exposure frequency for introducing a novel vegetable among children. *Foods, 10*(5), 913. https://doi.org/10.3390/foods10050913

Liao, S.-F., Tseng, H.-M., Chen, J.-D., Chen, C.-M., & Li, S.-C. (2025). A pilot evaluation of a school-based nutrition education program with provision of fruits and vegetables to improve consumption among school-age children in Palau. *Nutrients, 17*(6), 994. https://doi.org/10.3390/nu17060994

Melnick, E. M., Thomas, K., Farewell, C., Quinlan, J., LaFlamme, D., Brogden, D., Scarbro, S., & Puma, J. E. (2020). Impact of a nutrition education programme on preschool children's willingness to consume fruits and vegetables. *Public Health Nutrition, 23*(10), 1846–1853. https://doi.org/10.1017/S1368980019005032

Mogre, V., Sefogah, P. E., Adetunji, A. W., Olalekan, O. O., Gaa, P. K., Ayettey Anie, H. N. G., & Tayo, B. (2024). A school-based food and nutrition education intervention increases nutrition-related knowledge and fruit consumption among primary school children in northern Ghana. *BMC Public Health, 24*(1), 1739. https://doi.org/10.1186/s12889-024-19200-7

Nekitsing, C., Blundell-Birtill, P., Cockroft, J. E., & Hetherington, M. M. (2019). Taste exposure increases intake and nutrition education increases willingness to try an unfamiliar vegetable in preschool children: A cluster randomized trial. *Journal of the Academy of Nutrition and Dietetics, 119*(12), 2004–2013. https://doi.org/10.1016/j.jand.2019.05.012

Oddo, V. M., Roshita, A., Khan, M. T., Ariawan, I., Wiradnyani, L. A. A., Chakrabarti, S., Izwardy, D., & Rah, J. H. (2022). Evidence-based nutrition interventions improved adolescents' knowledge and behaviors in Indonesia. *Nutrients, 14*(9), 1717. https://doi.org/10.3390/nu14091717

Poelman, A. A. M., Cochet-Broch, M., Wiggins, B., McCrea, R., Heffernan, J. E., Beelen, J., & Cox, D. N. (2020). Effect of experiential vegetable education program on mediating factors of vegetable consumption in Australian primary school students: A cluster-randomized controlled trial. *Nutrients, 12*(8), 2343. https://doi.org/10.3390/nu12082343

Puspita, W. L., Khayan, Suaebah, Ihsan, B. M., & Hanif, M. I. (2024). Health education media to increase vegetable and fruit consumption in school-aged children. *Jurnal Promkes, 12*(2), 160–167. https://doi.org/10.20473/jpk.V12.I2.2024.160-167

Saha, S., Dawson, J., Murimi, M., Dodd, S., & Oldewage-Theron, W. (2020). Effects of a nutrition education intervention on fruit and vegetable consumption-related dietary behavioural factors among elementary school children. *Health Education Journal, 79*(8), 963–973. https://doi.org/10.1177/0017896920944421

Scherr, R. E., Jones, A. M., Colorafi, R., Klisch, S., Linnell, J. D., & Soule, K. E. (2021). Assessing the effectiveness of an extender model partnership in implementing a multicomponent, school-based nutrition intervention. *Health Promotion Practice, 22*(6), 890–898. https://doi.org/10.1177/1524839920920305

Schmitt, S. A., Bryant, L. M., Korucu, I., Kirkham, L., Katare, B., & Benjamin, T. (2019). The effects of a nutrition education curriculum on improving young children's fruit and vegetable preferences and nutrition and health knowledge. *Public Health Nutrition, 22*(1), 28–34. https://doi.org/10.1017/S1368980018002586

van Lier, I., van Mil, E., & Havermans, R. C. (2024). Long-term effects of a school-based experiential nutrition education intervention. *International Journal of Health Promotion and Education*. https://doi.org/10.1080/14635240.2024.2421557

Verdonschot, A., Follong, B. M., Collins, C. E., de Vet, E., Haveman-Nies, A., & Bucher, T. (2023). Effectiveness of school-based nutrition intervention components on fruit and vegetable intake and nutrition knowledge in children aged 4–12 years old: An umbrella review. *Nutrition Reviews, 81*(3), 304–321. https://doi.org/10.1093/nutrit/nuac057

World Health Organization (2023). *Carbohydrate intake for adults and children: WHO guideline*. https://www.who.int/publications/i/item/9789240073593