January – March, 2026
Original Article
DOI: http://dx.doi.org/10.30867/action.v11i1.2900

AcTion: Aceh Nutrition Journal
Pages: 112 – 124 | p-issn 2527-3310; e-issn 2548-5741

Theory of planned behavior–based nutrition education to enhance knowledge and fruit-vegetable consumption determinants among elementary school children in Bogor Regency

Edukasi gizi berbasis Theory of Planned Behavior untuk meningkatkan pengetahuan dan determinan konsumsi sayur dan buah pada anak sekolah dasar di Kabupaten Bogor

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Article History:
Received: September 23, 2025; Revised: October 29, 2025; Accepted: November 10, 2025; Published: March 04, 2026.

Publisher:
Politeknik Kesehatan Aceh
Kementerian Kesehatan RI

Abstract

Nutritional problems among school-age children remain significant, mainly due to unbalanced diets and low vegetable and fruit intake. In Indonesia, 97.7% of students do not meet the recommended consumption levels, with West Java reaching 98.3%. Most nutrition education programs emphasize knowledge improvement without considering the psychological factors influencing eating behavior. The Theory of Planned Behavior (TPB), which highlights the role of intention in shaping behavior, has rarely been applied in Indonesia. This study examined the effect of TPB-based nutrition education on knowledge, attitude, subjective norm, perceived behavioral control, and intention to consume vegetables and fruits among elementary students in Bogor District. Using a quasi-experimental design with multiple random sampling, 70 fifth-grade students were divided into treatment and control groups (n=35 each). The instruments showed good validity (r-count > r-table) and reliability (Cronbach's alpha > 0.7). The results indicated significant improvements in all TPB constructs ($p < 0.05$), except for subjective norm in the control group, with higher Cohen's d values in the treatment group. TPB-based nutrition education effectively enhanced students' intentions and behaviors toward consuming fruits and vegetables. Further research should consider longer interventions, follow-up evaluations, and the inclusion of additional influencing factors.

Keywords: Theory of Planned Behavior, booklet, fruit and vegetable consumption, school-age children, nutrition education.

Abstrak

Masalah gizi pada anak usia sekolah masih menjadi perhatian karena rendahnya konsumsi sayur dan buah. Sebanyak 97.7% anak sekolah di Indonesia belum memenuhi anjuran konsumsi, bahkan di Jawa Barat mencapai 98.3%. Program edukasi gizi yang ada umumnya berfokus pada peningkatan pengetahuan tanpa memperhatikan faktor psikologis yang memengaruhi perilaku makan. Pendekatan Theory of Planned Behavior (TPB), yang menekankan peran niat dalam pembentukan perilaku, masih jarang digunakan di Indonesia. Penelitian ini menilai pengaruh edukasi gizi berbasis TPB terhadap pengetahuan, sikap, norma subjektif, persepsi kontrol perilaku, dan niat konsumsi sayur serta buah pada siswa SD di Kabupaten Bogor. Desain penelitian menggunakan kuasi-eksperimen dengan multiple random sampling pada 70 siswa kelas V (kelompok perlakuan dan kontrol masing-masing 35 siswa). Instrumen telah teruji validitas (r-hitung > r-tabel) dan reliabilitasnya (Cronbach's alpha > 0.7). Hasil menunjukkan peningkatan signifikan pada semua konstruk TPB ($p < 0.05$), kecuali norma subjektif pada kelompok kontrol, dengan nilai Cohen's d lebih besar pada kelompok perlakuan. Edukasi gizi berbasis TPB

terbukti efektif meningkatkan perilaku konsumsi sayur dan buah. Penelitian lanjutan disarankan mempertimbangkan durasi, tindak lanjut, dan variabel tambahan.

Kata Kunci: Theory of Planned Behavior, anak usia sekolah, booklet, edukasi gizi, konsumsi sayur dan buah

Introduction

Growth and development in school-age children are essential for creating a healthy generation. To support this, children require adequate nutritional intake in terms of both quality and quantity, as nutrition is a key determinant of health and academic performance (Asad & Simon, 2025). However, various nutritional problems caused by inadequate intake are still prevalent, such as being overweight due to excessive consumption, underweight due to insufficient intake, and increased susceptibility to various diseases (Aulia, 2022).

Nutritional problems among school-aged children remain relatively high. Common conditions include stunting, severe thinness, obesity, being overweight, and anemia (Sulistyawati et al., 2019). The prevalence of stunting in school-age children was 18.5%, and that of severe stunting was 7.2%. The prevalence of thinness and severe thinness was 6.8% and 2.4%, respectively, whereas the prevalence of obesity and overweight was 10.8% and 9.2%, respectively. Anemia also remains a serious concern, with a prevalence of 26.8% (Hamzah, 2020). Low levels of physical activity and dietary changes characterized by high-fat and high-sugar food consumption are the main contributing factors to these nutritional problems (Suryamulyawan & Arimbawa 2019). Furthermore, nutritional problems are linked to lifestyle behaviors such as insufficient physical activity and poor dietary habits (Octaviani et al., 2018). One significant issue is the low consumption of vegetables and fruits, which contributes to various nutritional problems, including overnutrition (Farida et al., 2022). Inadequate consumption of vegetables and fruits also leads to deficiencies in essential nutrients, which may trigger nutrition-related diseases (Siegel 2019). Data from the Indonesian Health Survey (IHS) in 2023 reported that 97,7% of school-age children in Indonesia do not meet the recommended levels of fruit and vegetable consumption, with West Java showing an even higher rate of 98,3%. The urgency of this research lies in the fact that school age is a critical period for establishing healthy eating behavior. If vegetable and fruit consumption patterns are not improved early, this may have long-term consequences for children's health, increase the risk of degenerative diseases in adulthood, and reduce the overall quality of human resources in the future. Therefore, effective nutrition education interventions are needed to promote vegetable and fruit consumption among school-aged children.

This study uses the Theory of Planned Behavior (TPB) as a framework for nutrition education to improve vegetable and fruit consumption. There has been limited research in Indonesia applying this behavioral theory to nutrition interventions, particularly involving maternal roles and child-friendly educational methods. Previous studies have demonstrated the effectiveness of the TPB in modifying intentions, attitudes, subjective norms, and perceived behavioral control related to fruit and vegetable consumption (Saeed Jadgal et al., 2020; Taghdisi et al., 2016). Thus, this study offers a novel approach that is expected to provide optimal results in the local context. Based on the above, this study aimed to analyze the effect of nutrition education based on the Theory of Planned Behavior on improving vegetable and fruit consumption in school-age children.

Methods

This study was conducted using a pre-post quasi-experimental design with two groups: an intervention and a control group. The research was conducted from January to February 2025 at SDN 04 Bojong Rangkas and SDN 01 Cihideung Udik, located in Bogor Regency, West Java. The study sites were selected using multiple random sampling, considering factors such as parental acceptance of educational activities, ease of obtaining permits and school accessibility. West Java Province was chosen as the study area based on the Total Diet Survey (SDT) conducted by the National Institute of Health Research and

Development (Balitbangkes) in 2014, which reported that the average consumption of vegetables and fruits in West Java was below the national average of 47 g/day for vegetables and 29.8 g/day for fruits. Furthermore, data from the Indonesian Health Survey (IHS) in 2023 indicated that the proportion of individuals over the age of five who did not consume vegetables and fruits in West Java was higher than the national average, reaching 98,3% (SKI, 2023).

The intervention group received nutrition education related to the consumption of vegetables and fruits in school-aged children using booklets and PowerPoint presentations. In contrast, the control group received only leaflets on vegetables and fruits. Nutrition education was conducted over a 28-day period (4 weeks), comprising four weekly sessions. Intervention fidelity was maintained through the use of standardized educational modules and booklet media for each session. The facilitators received brief training on how to deliver the booklet content and manage discussions to ensure the consistent delivery of nutrition messages. Each session was documented and evaluated using an observation checklist to ensure consistency in the content and implementation duration.

The use of booklets has been shown to significantly improve parental nutritional knowledge of fruit and vegetable consumption (Hariani & Fathurahman, 2021). Booklets are a practical educational medium because their small size makes them easy to carry. Their content is generally concise and contains important nutritional messages (Al Rahmad et al., 2023; Emilda et al., 2024). A study conducted by Azadirachta and Sumarmi (2018) demonstrated that children who received booklets showed greater improvements in knowledge and attitudes than those who received only leaflets. The mean scores of knowledge (66.3±12.8) and practice (3.1±1.4) in the intervention group were higher than those in the control group, with mean knowledge (43.5±15.0) and practice (1.8±1.2) (Azadirachta & Sumarmi, 2018). From a cognitive perspective, text and images facilitate dual mental representation, with cognitive schemas serving as scaffolding for the construction of mental models, making stories and images highly effective in linking new information to preexisting cognitive frameworks (Schnotz et al., 2022). Meanwhile, from an affective perspective, highlighting the element of enjoyment within narratives or images may foster greater interest and more positive attitudes in children toward fruit consumption and, more broadly, toward healthy dietary habits (Appleton & Adams, 2023).

The materials delivered through the booklet included an introduction to balanced nutrition, the importance of consuming fruits and vegetables, the types, nutritional content, and benefits of fruits and vegetables, the recommended daily portions, and hygiene practices before consumption. The content of the booklet was compiled from various sources, including textbooks and relevant journal articles. The educational sessions for both children were developed based on the Theory of Planned Behavior (TPB), with the following detailed topics addressed in each session:

Tabel 1. Details of the nutrition education sessions based on the Theory of Planned Behavior (TPB)

Session	Session Objective	Time	Method
1	Build belief in the outcomes of fruit and vegetable consumption	15 minutes	Brainstorming, presentation, and discussion
2	Reinforce positive outcomes of fruit and vegetable consumption	10 minutes	Games and discussion
3	Shape subjective norms	15 minutes	Practice and discussion
4	Develop perceived behavioral control	10 minutes	Brainstorming and discussion
5	Implement behavioral intention	10 minutes	Discussion
Total duration of each session		60 minutes	

This study involved 70 fifth-grade elementary school children, who were equally divided into control (n=35) and intervention (n = 35) groups with relatively balanced academic ability levels and gender distribution. The participants were not informed about their group allocation. The sample size in this study was determined based on calculations using secondary data from Nababan (2012), with nutrition knowledge scores as the reference variable. The calculation considered a mean difference of 8,7 a standard deviation of 11,9 a significance level of 5%, and a statistical power of 80%. The sample size was calculated using the

formula recommended by the World Health Organization (WHO, 1996) for studies involving two groups, which considers the standard deviation, significance level, test power, and expected mean difference between groups, as shown in the following equation:

$$n \geq (2\,(s)^2\,(Z\beta + Z\alpha)^2)/d^2$$

Explanation:
n : Sample size per group
s : Standard deviation
$Z_{1-\alpha}$: Significance level (1.96 for Alpha 5%)
$Z_{1-\beta}$: Test power (80%)
d : Expected score difference between 2 group

Based on these parameters, a minimum of 29 respondents per group was required. To anticipate possible refusals or dropouts during the study, an additional 20% of participants were included. Therefore, the minimum required sample size for each group was 35. The data collected included the characteristics of school-aged children (age, gender, pocket money, and nutritional status) as well as nutritional knowledge and behavioral determinants measured using constructs from the Theory of Planned Behavior, including attitude, subjective norm, perceived behavioral control, and behavioral intention. Data were collected at both baseline and the end of the nutrition education intervention (endline).

Nutritional knowledge and behavioral determinants were assessed using validated questionnaires (r-calculated > r-table) and tested for reliability, yielding Cronbach's alpha values greater than 0.7. The researchers also controlled for external variables, such as exposure to nutrition information outside the intervention, by asking the students not to participate in similar activities during the study period. These measures were implemented to ensure that the differences in outcomes between the intervention and control groups were attributable to the Theory of Planned Behavior-based nutrition education intervention. The questionnaire consisted of 26 questions on knowledge, 10 questions on fruit and vegetable preferences, 20 questions on attitude, 23 questions on subjective norms, 15 questions on perceived behavioral control, and 11 questions on behavioral intentions. The questionnaires were completed directly and offline by each respondent using printed form. Knowledge questions were scored as 1 point for each correct answer and 0 points for each incorrect answer. For constructs under the Theory of Planned Behavior, namely attitude, subjective norm, perceived behavioral control, and behavioral intention, final scores were calculated using the average score of each respective construct. Knowledge scores were categorized into three levels: good (>80), moderate (60–80), and poor (<60) (Khomsan, 2022).

Data analysis was performed using the IBM SPSS version 26. Descriptive statistics were used to describe the characteristics of the study participants. Additional data analyses included the Shapiro-Wilk test for normality, Spearman's rank correlation test, the Independent sample t-test and Mann Whitney test to assess differences between the two intervention groups, the Paired Sample t-test and Wilcoxon signed rank test to evaluate pre and post intervention differences.

This study was approved by the Health Research Ethics Committee of the Faculty of Dentistry, Airlangga University (Approval No. 788/HRECC.FODM/VII/2024).

Result and Discussion

The characteristics of the respondents in both groups observed in this study included child-related variables such as age, sex, allowance, and nutritional status. The maternal characteristics included age, education, occupation, and income (Table 2). Children's age was categorized into two tertiles, while maternal age was categorized into three tertiles based on the statistical data distribution. Maternal education was divided into four levels according to the educational attainment. Maternal occupation was initially classified into five categories; however, data distribution was observed in only two categories. Income was divided into two categories based on the distribution of the statistical data.

Tabel 2. Distribution of characteristics of respondents in the control and intervention groups

Characteristics	Control Group (n= 35)		Intervention Group (n= 35)	
	n	%	n	%
School-age children				
Age				
10-11 years	34	97.1	33	94.3
12-13 years	1	2.9	2	5.7
Gender				
Male	13	37.1	17	48.6

Female	22	62.9	18	51.4
Allowance				
<5000	2	5.7	1	2.9
>5000	33	94.3	34	97.1
Nutritional status				
Under weight	11	31.4	8	22.9
Normal	12	34.3	21	60.0
Overweight	12	34.3	6	17.1
Family Education level (mother)				
ES / equivalent	3	8.6	3	8.6
JHS / equivalent	9	25.7	3	8.6
SHS / equivalent	23	65.7	26	74.3
Higher education	0	0	3	8.6
Occupation (father)				
Self-employed/ entrepreneur	9	25.7	9	25.7
Private employed	3	8.6	10	28.6
Farmer	23	65.7	10	28.6
Civil servant/military/ police	0	0	4	11.4
Family Income				
1.500.000-1.999.000	3	8.6	1	2.9
≥2.000.000	32	91.4	34	97.1

Most of the children in both groups were aged 10–11 years, indicating that the intervention was carried out at the upper elementary school level, a critical period for the development of healthy eating habits (Hartanto, 2025). The majority of children also had a daily allowance of more than IDR 5,000, which may have influenced their food choices outside the home. This finding is consistent with previous research reporting that the amount of pocket money is associated with snacking behavior among schoolchildren (Nur Asni Arti & Suprianto, 2020). The highest educational attainment of mothers was predominantly senior high school (or equivalent), with only a small proportion pursuing higher education. Maternal education has been shown to significantly influences child feeding practices (Isfaizah et al., 2024). Higher levels of education are associated with better nutritional knowledge (Adri et al., 2024).

In terms of income, most families were in the ≥ IDR 2,000,000 category, which corresponds to the average household income aligned with the Provincial Minimum Wage (UMR) of West Java in 2025, amounting to IDR 2,191,232 (Keputusan Gubernur Jawa Barat Nomor 561/Kep.778-Kesra/2024 Tentang Upah Minimum Provinsi Jawa Barat Tahun 2025). Socioeconomic factors, including household income and parental occupation, are known to affect children's nutritional status through the ability to provide nutritious food and access health-related information (Supariasa, 2016). A comparison of knowledge and behavioral determinants based on the Theory of Planned Behavior (TPB), including attitude, subjective norm, perceived behavioral control, and behavioral intention, is presented in Table 3.

Tabel 3. Comparison of knowledge, behavioral determinant based on the TPB constructs in Intervention and Control Groups before and after nutrition education

Variable	Group	Intervention	Control	p-value[a]
		Mean ± SD	Mean ± SD	
Knowledge	Before education	71.23 ± 11.53	61.46 ± 14.71	0.001
	Good	10 (28.6%)	3 (8.6%)	
	Moderate	20 (57.1%)	29 (82.9%)	
	Poor	5 (14.3%)	3 (8.6%)	
	After education	90.09 ± 6.98	65.71 ± 12.67	0.000
	Good	31 (88.6%)	2 (5.7%)	
	Moderate	4 (11.4%)	32 (91.4%)	
	Poor	-	1 (2.9%)	
	p-value[b]	0.000*	0.000*	
	Cohen's d	1.86	0.33	
Attitude	Before education	84.20 ± 6.75	61.46 ± 14.71	0.112
	After education	89.94 ± 7.41	81.69 ± 9.40	0.000
	p-value[b]	0.000*	0.000*	
	Cohen's d	1.86	0.33	
Subjective norm	Before education	81.40 ± 8.76	77.23 ± 8.97	0.123

	After education	88.97 ± 8.01	76.83 ± 7.85	0.000
	p-value[b]	0.000*	0.705	
	Cohen's d	0.88	0.05	
Perceived behavioral control	Before education	79.09 ± 12.09	76.80 ± 14.38	0.474
	After education	95.26 ± 4.92	83.77 ± 11.52	0.000
	p-value	0.000*	0.002*	
	Cohen's d	1.72	0.55	
Behavioral intention	Before education	82.11 ± 10.94	77.66 ± 9.33	0.226
	After education	95.89 ± 5.60	81.20 ± 9.86	0.000
	p-value[b]	0.000*	0.006*	
	Cohen's d	1.44	0.39	

**Significant at p-value ≤0,005; [a]Mann Whitney; [b]Wilcoxon signed-rank test*

As shown in Table 3, the nutrition education intervention resulted in a significant increase in knowledge among the intervention group. Before the education, only 28.6% of students had knowledge in the good category, but after the education, the figure increased to 88.6%, with no students remaining in the poor category. In contrast, there was no meaningful change in the control group, where most students remained in the moderate category, and the proportion of those with good knowledge slightly decreased from 8.6% to 5.7%. Following the implementation of nutrition education, there was a significant improvement in students' knowledge and behavioral determinants related to fruit and vegetable consumption, in accordance with the Theory of Planned Behavior (TPB) constructs. The mean knowledge score of the intervention group increased from 71.23 ± 11.53 to 90.09 ± 6.98 (p = 0.000; Cohen's d = 1.86), while the control group showed no significant change.

Additionally, there was a significant increase in the TPB construct scores for the intervention group, with Cohen's d values ranging from 0.80 to 1.86, indicating a large effect. The attitude construct increased by 5.70 points, subjective norms by 7.49, perceived behavioral control by 15.97, and behavioral intention by 13.78 points. In contrast, the control group showed Cohen's d values below 0,80 across all constructs, indicating no substantial effect between pre- and post-intervention, despite some significant changes in a few constructs. These results demonstrate that nutrition education not only improved knowledge but also fostered positive attitudes, strengthened social support, enhanced self-confidence, and motivated students to adopt fruit and vegetable consumption behavior. Thus, nutrition education strongly influenced students' knowledge, attitudes, subjective norms, perceived behavioral control, and intention to consume fruits and vegetables.

This study demonstrates that nutrition education based on the Theory of Planned Behavior (TPB) effectively improves students' knowledge, attitudes, subjective norms, perceived behavioral control (PBC), and behavioral intentions toward consuming fruits and vegetables. These findings are consistent with previous studies that have proven the effectiveness of the TPB framework in shaping healthy eating behaviors among elementary school children (Darabi et al., 2025; Taghdisi et al., 2016). However, the present findings not only confirm earlier results but also strengthen the evidence that cognitive changes (knowledge and attitudes) can interact synergistically with social factors and individual control perceptions, which in turn enhance intentions toward fruit and vegetable consumption behavior.

The increase in students' knowledge after the intervention indicates that TPB-based nutrition education is effective in strengthening the conceptual understanding of the importance of fruit and vegetable consumption. Knowledge serves as a cognitive foundation that influences the formation of attitudes, subjective norms, and perceived behavioral control, which ultimately contribute to increased intention to engage in healthy behaviors (Maleki et al., 2016). Delivering material through interactive booklet media facilitates a more meaningful learning process compared to conventional lecture methods, as students can learn information visually and repetitively (Aulia et al., 2024). The effectiveness of illustrated print media can enhance nutrition knowledge among school children (Hosseini et al., 2015; Tiara et al., 2019). Nutrition knowledge acts as the cognitive basis for individuals' decision-making when choosing

foods that support nutritional balance and overall health (Juari et al., 2021). Good nutritional knowledge increases fruit and vegetable consumption as part of a healthy diet (Nay et al., 2020). Maintaining a healthy eating pattern during adulthood can reduce disease risk and improve individual quality of life (Herlianty et al., 2024).

Attitudes showed a significant positive change after the intervention. The increase in attitude scores in the intervention group reflects the success of the interactive educational media in altering students' affective and cognitive evaluations of fruit and vegetable consumption behaviors. TPB-based education can facilitate changes in students' perspectives on fruit and vegetable consumption (Afifah et al., 2024). Engaging and age-appropriate educational media have proven more effective in eliciting positive emotional responses and fostering supportive attitudes (Anisa et al., 2025; Winy Liveline Suryani et al., 2023). Compared to the control group, which only received a leaflet, the interactive approach used in this study resulted in greater attitude changes, reinforcing the evidence that active participant engagement is key to behavioral modification (Haya Faradila et al., 2024). The formation of positive attitudes directly contributes to increased behavioral intentions, as described in the TPB. However, this needs to be supported by continuous strategies to ensure that actual behavioral changes occur both at school and home (Sariana et al., 2025).

Children's eating behaviors are influenced by various social factors in their environment, particularly family and peers. Parents play a central role in instilling healthy eating values and habits, as dietary principles or patterns practiced within the family are often passed down to children (Saifah et al., 2019). In addition, peers significantly contribute to the development of children's eating behavior, particularly through social interactions and shared activities outside the home, which are an integral part of school-aged children's lives (Kamila et al., 2025). Evidence further highlights that collaboration between schools, families, and the broader community is highly influential in the development of children's eating behavior (Jatmikowati et al., 2023).

As subjective norms reflect social influence on behavioral decisions, interventions that incorporate social approaches are considered more effective in shaping these norms. Subjective norms reflect social influence in behavioral decision-making; therefore, social-based interventions, such as interactive nutrition education in schools through games, discussions, and healthy menu simulations, have proven effective in shaping children's dietary norms and significantly improving healthy eating behaviors (Mufaiduddin et al. 2024). Subjective norms also increased significantly in the intervention group, indicating a strong social influence of teachers, peers, and family on children's eating decisions. This change shows that nutrition education not only affects individuals cognitively but also shifts their perception of social support within their environment (Gong & Zheng, 2025). The involvement of parents and teachers as positive behavioral role models strengthens social norms for the consumption of healthy foods (Jatmikowati et al., 2023; Khani et al., 2021).

School and family environments play major roles in shaping children's eating habits (Makori et al., 2025). Support from teachers and parents and the provision of healthy food facilities at school can enhance the understanding and practice of balanced nutrition from an early age (Zekaria et al., 2025). Involving children in family discussions and providing them with opportunities to make decisions can improve healthy eating behaviors, including fruit and vegetable consumption (Moore et al., 2022). This underscores the importance of integrating social approaches into TPB-based interventions, as strong subjective norms can reinforce both intention and actual behavior in school and home contexts (Stok et al. 2014). The absence of significant changes in the control group may be due to the passive nature of the educational method used, which lacked social interactions. Delivering information through leaflets alone is insufficient to shape children's perceptions of social support that encourages healthy eating behaviors (Hang et al., 2019).

One of the constructs in the Theory of Planned Behavior (TPB), perceived behavioral control (PBC), refers to an individual's belief regarding the availability of resources necessary to perform a behavior. The presence of these resources is perceived as a facilitating factor, whereas their absence is viewed as a barrier to performing the behavior (Arianto & Gozali, 2025). Perceived Behavioral Control (PBC) in the Theory of Planned Behavior (TPB) describes the extent to

which individuals feel capable of controlling their behavior, which is influenced by the availability of resources, abilities, and opportunities to act (Ajzen, 2020). The significant increase in perceived behavioral control (PBC) indicates that students felt more capable and had the resources needed to engage in fruit and vegetable consumption behaviors. Activities such as discussions, games, and problem-solving encourage the development of practical strategies for selecting and consuming fruits and vegetables (Handarbeny & Mahmudiono, 2017). These activities not only transferred information but also provided space for children to practice decision-making and discover concrete strategies for consuming fruits and vegetables (Yulianti et al., 2021). This process strengthened children's control beliefs regarding healthy eating behaviors, aligning with findings that experiential learning enhances self-efficacy and perceived behavioral control (Maleki et al., 2016; Ranaei et al., 2025). With an increased perception of their own ability, students became more confident that they could maintain healthy eating habits, even when facing environmental limitations.

Behavioral intention reflects an individual's commitment and readiness to act, which is formed through the interaction between attitude, subjective norms, and perceived behavioral control. The significant increase in the intention construct score reflects the cumulative result of changes in attitude, subjective norms, and perceived behavioral control. This increase in behavioral intention indicates the success of the intervention in integrating the cognitive and social factors that drive the intention to act (Al Rahmad et al., 2022; Gouveia et al., 2023). However, a high level of behavioral intention does not necessarily guarantee an actual change in behavior, as the implementation of fruit and vegetable consumption can still be hindered by factors such as availability, environmental influences, and family eating habits (Luthviah et al., 2025; Safitriani & Masnina, 2022). Therefore, it is necessary to strengthen perceived control and develop implementation planning strategies to reduce the gap between intention and actual behavior (Arachchige et al., 2023). Strengthening behavioral intention can improve adherence to healthy behaviors, particularly when supported by reminder systems or external reinforcement (Ferdianto et al., 2025; Riebl et al., 2015).

A comparison between the two groups revealed that the intervention group experienced more substantial improvements across all components of the Theory of Planned Behavior (TPB). These findings suggest that nutrition education grounded in TPB principles is more effective than passive methods, such as leaflets (Rakhshani et al., 2025). Interactive media provide both visual and auditory stimulation, facilitating better comprehension and retention. This finding is consistent with earlier studies that underscore the importance of utilizing interactive and multisensory media to convey health education to children (Wahyuni et al., 2021). Similarly, Priawantiputri et al. (2019) found that the use of flashcards notably enhanced students' knowledge about nutrition, while Jatmika et al. (2019) reinforced the pivotal role of educational media in health communication. Furthermore, Maryam (2024) noted that effective media not only improve the transmission of information but also play a vital role in promoting behavior change, thereby serving as an essential element in public health interventions.

However, this study had several limitations. The relatively small sample size may limit the generalizability of the findings to a broader population. In addition, the short duration of the intervention may not have been sufficient to observe long-term behavioral changes. Future studies should involve larger samples and longer follow-up periods to strengthen the evidence regarding the effectiveness of the intervention.

Conclusion

This study showed that nutrition education based on the Theory of Planned Behavior (TPB) significantly improved students' knowledge, attitudes, subjective norms, perceived behavioral control, and intentions toward fruit and vegetable consumption in the intervention group. In contrast, no significant change was observed in the subjective norm construct in the control group. These findings confirm that interactive educational approaches combining booklets and presentations are effective in shaping healthy eating behaviors among elementary school children. The results suggest that TPB-based interventions should be integrated into school nutrition programs as part of broader strategies to promote healthy eating habits at the national scale. Furthermore, this study provides valuable insights for policymakers and educators to

develop more comprehensive and sustainable nutrition education models.

Future implementation of similar programs is recommended to actively involve parents in monitoring children's dietary practices at home, engage teachers in incorporating nutrition topics into classroom learning, and collaborate with school food vendors to ensure the availability of healthier food options in schools. Such collaborative efforts are expected to strengthen the effectiveness of interventions and foster a supportive school environment that sustains healthy eating behaviors over the long term.

Acknowledgments

The research team would like to express their sincere appreciation to SDN 04 Bojong Rangkas and SDN 01 Cihideung Udik in Bogor Regency, West Java, for their participation and support as research sites for this nutrition education study. We also extend our gratitude to all parties who contributed to the success of this study.

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