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Research Article

THE EFFECT OF EDUCATIONAL PUZZLE GAMES ON BALANCED NUTRITION KNOWLEDGE AND ATTITUDES AMONG JUNIOR HIGH SCHOOL STUDENTS AT SMP NEGERI 7 BUKITTINGGI IN 2025

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ABSTRACT

Background:
Adolescent nutrition is a complex public health issue, encompassing undernutrition, overnutrition, and micronutrient deficiencies such as anemia. Nutritional imbalances during adolescence affect physical growth, brain development, academic performance, and long-term productivity. Therefore, innovative, engaging, and age-appropriate educational approaches are necessary. One such effective method is the use of educational games such as puzzles, which present nutritional messages in an interactive and enjoyable way. This study aimed to analyze the effect of the Balanced Nutrition Puzzle Game on students' knowledge and attitudes toward balanced nutrition.
Methods: A quasi-experimental design with a pre-test and post-test control group was used. The sample consisted of 60 junior high school students selected through purposive sampling, with valid and reliable questionnaires used as instruments.
Results: The results showed a significant increase in knowledge and attitude scores in the intervention group after the puzzle game was implemented ($p < 0.05$), whereas the control group showed no significant changes.
Conclusion: These findings suggest that the Balanced Nutrition Puzzle Game is an effective educational medium for improving adolescent understanding and promoting positive attitudes toward healthy eating and lifestyle.

Keywords: Balanced Nutrition, Nutrition Education, Educational Game, Puzzle, Adolescents

INTRODUCTION

In West Sumatra Province, particularly in Bukittinggi City, this issue is clearly visible. The prevalence of undernutrition among adolescents reaches 22.2%, with overweight at 10.6%, obesity at 4.1%, and anemia at 32%. Specifically in Bukittinggi, 12.6% of students are underweight and 3.1% are overweight, indicating a gap in achieving balanced nutrition among junior high school students[3]. UPTD Puskesmas Tigo Baleh, covering the city's largest working area, is frequently targeted for nutritional assessments. At SMP Negeri 7 Bukittinggi, located within this area, data showed that out of 285 students, 20% were severely underweight, 8% were underweight, and 10.2% were overweight. This imbalance highlights the need for effective educational interventions to improve adolescents' knowledge and attitudes toward balanced nutrition.

Improving adolescent nutrition requires comprehensive strategies, including engaging and accessible educational approaches. Educational games have proven effective in enhancing students' knowledge and attitudes toward balanced nutrition[7] [8]. Puzzle-based educational games, in particular, allow students to learn actively and interactively, helping them to better understand food types and groups while stimulating interest and participation in learning[8].

Previous studies also indicate that educational media such as puzzles, nutrition cards, and simulation games can enhance students' understanding and attitudes toward fruit and vegetable consumption[7] [8]. Therefore, it is important to continue developing innovative, printed, game-based learning media that are appropriate for students' age and characteristics.

MATERIAL AND METHODS

Study Design

This research employed a quantitative approach using a quasi-experimental design with a pre-test and post-test control group. The objective was to determine the effectiveness of an educational medium in the form of a Balanced Nutrition Puzzle Game in improving junior high school students' knowledge and attitudes regarding balanced nutrition. Two groups were involved: the intervention group, which received the educational game, and the control group, which received no intervention but participated in both pre- and post-tests.

Location and Time of Study

The study was conducted in two public junior high schools in Bukittinggi City: SMP Negeri 7 Bukittinggi (intervention group) and SMP Negeri 4 Bukittinggi (control group). These schools were selected purposively based on accreditation level (A), high academic performance, and supportive infrastructure for implementing the intervention. The study took place from January to July 2025, encompassing preparation, intervention implementation, data collection, and data analysis phases.

Population and Sample

The study population consisted of all Grade VII students in Bukittinggi City. The sample was selected through purposive sampling using the following inclusion criteria: (1) students identified by the school as having issues related to balanced nutrition, and (2) students who agreed to participate in the entire research process. A total of 60 students were involved, evenly divided into two groups: 30 students in the intervention group and 30 in the control group.

Research Instruments

Data were collected using validated and reliable questionnaires measuring students' knowledge and attitudes toward balanced nutrition. The knowledge questionnaire consisted of 15 multiple-choice items (true/false format), while the attitude questionnaire comprised 15 statements using a 4-point Likert scale: 1 = strongly disagree, 2 = disagree, 3 = agree, and 4 = strongly agree. Reliability testing produced Cronbach's Alpha values of 0.832 for the knowledge scale and 0.807 for the attitude scale, indicating good internal consistency. Content validity was confirmed through expert review by professionals in nutrition and education.

Intervention Media

The intervention utilized a Balanced Nutrition Puzzle Game consisting of 9 puzzle pieces: 4 main pieces illustrating components of a balanced nutrition plate (carbohydrates, proteins, vegetables, and fruits) and 5 additional pieces containing healthy lifestyle messages (handwashing, physical activity, drinking water, weight monitoring, and limiting sugar, salt, and fat). The game was implemented in two sessions: the first focused on the main food groups, and the second combined all puzzle elements. Game performance was evaluated based on the speed and accuracy of puzzle completion by student sub-teams.

Data Collection Procedure

Initial data collection began with administering a pre-test to all respondents to assess baseline knowledge and attitudes. The intervention group then participated in three educational sessions using the puzzle game over one week, while the control group received no intervention. Fourteen days after the pre-test, all participants were given the same post-test questionnaire. All sessions were conducted under the supervision of teachers and trained facilitators. Collected data were then edited, coded, entered, and cleaned prior to analysis.

Data Analysis

Data analysis was conducted using SPSS version 23. Univariate analysis was used to describe respondent characteristics such as age, gender, baseline knowledge, and attitude levels. Shapiro-Wilk normality tests indicated non-normal distribution ($p < 0.05$), prompting the use of non-parametric tests: the Wilcoxon Signed Rank Test to compare pre- and post-test scores within groups, and the Mann-Whitney U Test to compare between groups. The N-Gain Score formula was also used to assess the effectiveness of the intervention in improving knowledge and attitudes.

Ethical Approval

This study received ethical clearance from the Research Ethics Committee of the Faculty of Public Health, Universitas Andalas. All participating students and their parents or guardians were fully informed about the study objectives and procedures, and written informed consent was obtained. Participant confidentiality was maintained throughout the research and data were used solely for academic purposes.

RESULTS

Respondent Characteristics

The majority of respondents in this study were 13 years old (60%) and male (56.7%).

Table 1. Age and Gender Characteristics of Respondents

Variable	Intervention Group (n=30)		Control Group (n=30)		Total	
	f	%	f	%	f	%
Age (Years)						
12	3	10,0	3	10,0	6	10,0
13	15	50,0	21	70,0	36	60,0
14	10	33,3	6	20,0	16	26,7
15	0	0,0	0	0,0	0	0,0
16	1	3,3	0	0,0	1	1,7
17	1	3,3	0	0,0	1	1,7
Gender						
Male	18	60,0	16	53,3	34	56,7
Female	12	40,0	14	46,7	26	43,3

These results indicate that most participants were in early adolescence a critical period for shaping nutritional knowledge and attitudes.

Knowledge Before and After the Intervention

Table 2. Pre-Test and Post-Test Knowledge Scores in the Intervention and Control Groups

Knowledge	Intervention Group (n=30)			Control Group (n=30)		
	Median	*Mean±SD*	Min-Max	*Median*	*Mean±SD*	Min-Max
Pre Test	9	8,73±1,53	5-11	9	8,57±1,63	5-12
Post Test	13	12,6±1,07	11-14	9	9,03±1,19	7-12

The data show a notable increase in knowledge scores in the intervention group after receiving the Balanced Nutrition Puzzle Game intervention, with the mean score rising from 8.73 to 12.6. In contrast, the control group showed only a minimal change, with an increase of just 0.46 points.
Attitude Distribution Before and After the Intervention

Table 3. Pre-Test and Post-Test Attitude Scores in the Intervention and Control Groups

Atitude	Intervention Group (n=30)			Control Group (n=30)		
	Median	*Mean±SD*	Min-Max	*Median*	*Mean±SD*	Min-Max
Pre Test	42	41,47±3,51	34-49	41	40,7±3,65	34-51
Post Test	50	50,03±2,51	46-54	43	42,97±2,4 4	39-50

A significant improvement in attitude scores was also observed in the intervention group, increasing from a mean of 41.47 to 50.03. The control group, on the other hand, showed a smaller increase from 40.7 to 42.97.

Comparison of Knowledge Score Changes

Table 4. Differences in Knowledge Scores Before and After the Intervention

Knowledge	*Mean* (Min–Max)		Δ	*p-value*
	Pre	Post		
Intervention	8,73(5–11)	12,6(11–14)	3,87	0,0001
Control	8,57(5–12)	9,03(7–12)	0,46	0,306

Only the intervention group showed a statistically significant improvement in knowledge scores (p = 0.0001), while the control group did not.

Difference in Knowledge Score Gains Between Groups

Table 5. Differences in Knowledge Score Changes Between the Intervention and Control Groups

knowledge	Δ	*p-value*
Intervention	3,87	0,0001
Control	0,46	

The mean knowledge gain in the intervention group was 3.87, compared to just 0.46 in the control group. This difference was statistically significant (p = 0.0001), indicating the effectiveness of the educational puzzle game.

Comparison of Attitude Score Changes

Table 6. Differences in Attitude Scores Before and After the Intervention

Attitude	*Mean* (Min–Max)		Δ	*p-value*
	Pre	Post		
Intervention	41,47(34–49)	50,03(46–54)	8,56	0,0001
Control	40,7(34–51)	42,97(39–50)	2,27	0,02

Attitude scores in the intervention group increased by 8.56 points (from 41.47 to 50.03; p = 0.0001), while the control group showed a smaller gain of 2.27 points (p = 0.02).

Difference in Attitude Score Gains Between Groups

Table 7. Differences in Attitude Score Changes Between the Intervention and Control Groups

Knowledge	Δ	*p-value*
Intervention	8,56	0,0001
Control	2,27	

The increase in attitude scores was significantly greater in the intervention group (Δ = 8.56) than in the control group (Δ = 2.27), with p = 0.0001, confirming the positive influence of the educational game.

Effectiveness of the Puzzle Game Intervention

Table 8. Effectiveness of the Puzzle Game on Knowledge and Attitude Based on N-Gain Scores

Variable	Average
Knowledge	0,59
Attitude	0,44

Based on the N-Gain score analysis, the average gain for knowledge was 0.59 and for attitude was 0.44. These results suggest that the Balanced Nutrition Puzzle Game had a moderate level of effectiveness in improving both knowledge and attitude among junior high school students in the intervention group.

DISCUSSION

The participants in this study were junior high school students aged 12 to 17 years, with the majority aged 13 (60.0%). This age represents the early adolescent stage, a period of rapid cognitive and emotional development. During this stage, enjoyable educational approaches such as interactive games are particularly effective in enhancing student engagement and understanding. Hargreaves et al. (2022) emphasized that early adolescents are more likely to absorb information when presented through varied and interactive methods, including educational games that stimulate creativity and critical thinking[1].

In terms of gender, 56.7% of the respondents were male and 43.3% female. This relatively balanced composition allows the findings to be considered representative of junior high school students. According to Patimah, Idrus, and Noviasty (2023), female students often demonstrate greater discipline and involvement in educational activities. However, when educational games are designed to suit the characteristics of both

genders, they can facilitate effective learning for all students[9]. Overall, the respondent characteristics support the potential effectiveness of game-based education in delivering balanced nutrition content.

Knowledge Before and After Intervention

This study found a significant improvement in the knowledge scores of the intervention group, with the average score increasing from 8.73 to 12.6, and the median rising from 9 to 13. This indicates that puzzle-based education not only raised the mean score but also expanded students' overall understanding. Meanwhile, the control group experienced minimal changes, with a stagnant median and some decreases in specific items, highlighting the limited impact of passive information delivery.

Notable improvements were observed in items related to key balanced nutrition principles, such as fat intake recommendations, food diversity, portion control, fruit and water consumption, and maintaining a healthy weight. However, some areas—like the recommended portions of vegetables and fruits or daily physical activity—remained challenging.

These findings align with studies by Lorenza et al. (2021), which showed that interactive visual media improved adolescent nutritional understanding[10]. Similarly, Rakhman et al. (2024) demonstrated that puzzle-based tools significantly increased knowledge among elementary students[11]. On the other hand, Munir et al. (2024) reported the limited effectiveness of printed materials without interactive methods[11]. Overall, these results emphasize the importance of participatory and multisensory approaches in adolescent nutrition education.

Attitude Before and After Intervention

A significant increase was also observed in the intervention group's attitude scores, rising from a mean of 41.47 to 50.03, with the median increasing from 42 to 50. In contrast, the control group showed only a modest improvement. This highlights that educational games not only increase knowledge but also positively influence students' attitudes.

Improvements were particularly strong in items related to fruit consumption, proper protein portions, fat limitation, and healthy habits such as handwashing and weight monitoring. Negative attitude statements were also more strongly rejected after the intervention.

These results are consistent with studies by Maryati and Riya (2023), who found that engaging nutrition education could significantly shape adolescents' attitudes[12]. Shopia et al. (2024) also demonstrated the emotional and attitudinal impact of motion video media[13]. However, awareness related to limiting sugar, salt, and fat intake still requires deeper, more practical learning strategies, as recommended by Ibrahim and Maesarah (2024), who emphasized the role of meaningful, experience-based learning[14].

In summary, interactive, game-based educational approaches are effective in shaping adolescents' attitudes toward nutrition, but sustained change requires contextual and ongoing strategies.

Knowledge Score Changes

A statistically significant increase in knowledge scores was observed in the intervention group ($\Delta = 3.87$), while the control group experienced only a slight and non-significant increase ($\Delta = 0.46$). This

reinforces the conclusion that puzzle games are effective in enhancing students' conceptual understanding of balanced nutrition.

The game successfully addressed common misconceptions—such as the importance of physical activity, correct portion sizes, and the need to limit sugar and fat. Prior to the intervention, many students answered these items incorrectly; afterward, most intervention group participants answered correctly.

These findings support constructivist learning theories and multisensory learning principles, aligning with research by Madinah et al. (2024) and Wijayanti et al. (2021), who found that interactive educational media significantly improve both knowledge and attitudes[15] [16]. Zahira (2024) also noted the effectiveness of combining methods like brainstorming and digital games, especially among female adolescents[17].

Attitude Score Changes

The intervention group experienced a statistically significant increase in attitude scores ($\Delta = 8.56$; $p = 0.0001$), while the control group showed a smaller increase ($\Delta = 2.27$; $p = 0.02$). This confirms the stronger impact of educational games on attitude formation compared to conventional methods.

Post-intervention, students in the intervention group demonstrated more positive and reflective attitudes toward nutritional practices, including daily physical activity, appropriate vegetable portions, and limiting protein dominance on the plate.

These results are in line with studies by Hisanah et al. (2023), Ramadhanti et al. (2021), and Agusti (2021), all of which found that group-based educational games and interactive media significantly improved adolescent attitudes toward health behaviors[18] [19] [20].

Effectiveness of the Puzzle Game

The Balanced Nutrition Puzzle Game showed a moderate level of effectiveness in improving both knowledge and attitudes, as indicated by N-Gain scores of 0.59 and 0.44, respectively. This approach aligns with constructivist principles and multisensory learning strategies that engage cognitive and emotional processes simultaneously.

Madinah et al. (2024) found that games such as Snakes and Ladders were more effective than lectures in nutrition education[16]. Similarly, Wijayanti et al. (2021) reported that game-based approaches positively influenced understanding and healthy eating behaviors among adolescents[15]. Other studies using media such as booklets, board games, or motion graphics also reported significant improvements in nutritional attitudes[18] [19].

While video-based education may generate emotional appeal, puzzles have the advantage of encouraging more active cognitive engagement. Combining puzzle games with audiovisual tools could therefore enhance both knowledge retention and behavioral change

CONCLUSION

This study demonstrates that educational interventions using the "Balanced Nutrition Puzzle Game" significantly improve adolescents' knowledge and attitudes toward balanced nutrition. The intervention group, which participated in game-based education, showed a substantially greater increase in both knowledge and attitude scores compared to the control group, which only

received printed nutrition posters. Statistical analysis confirmed that these differences were significant ($p < 0.05$).

The findings support the idea that interactive and enjoyable learning methods are more effective for delivering nutrition education to adolescents. Educational games not only enhance conceptual understanding but also foster positive attitudes toward healthy dietary practices. This approach is well-suited to the developmental characteristics of adolescents, who benefit from emotionally engaging and participatory strategies.

In conclusion, game-based nutrition education can serve as an effective alternative strategy to increase nutrition literacy among school-aged adolescents. Such interventions hold strong potential for promoting healthy lifestyles from an early age and should be integrated into school health programs and community-based initiatives for long-term sustainability.

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