Physical activity-based nutrition educational games interventions for elementary school children

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Abstract

Purpose: An approach that can be used in delivering messages to children is the gamification method or game-based learning. This study aims to determine the effect of physical activity-based nutrition educational games on school children's nutritional status and nutrition knowledge. **Method:** This study used a quasi-experimental method with a one-group pretest-posttest with a control design. The intervention group was given physical activity-based nutrition educational games, namely "healthy eating plate" and "healthy food race" for 15 minutes for each game, once a week for nine weeks. Data analysis used paired sample t-test and independent t-test. **Result:** In the two groups, the anthropometric data differed only on body weight between the pre and post (p=0.000). The nutrition knowledge means score between the pre and post of intervention showed a significant difference (p=0.016) in the intervention group but not in the control group. The physical activity-based nutrition educational games affected body weight (p=0.000) and nutrition knowledge (p=0.016). **Conclusion:** Physical activity-based nutrition educational games (total duration 30 minutes) for nine weeks can increase nutrition knowledge and maintain normal weight in elementary school children.

Keywords: elementary school children; nutrition educational games; physical activity; nutrition knowledge; body weight

INTRODUCTION

Case obesity in children was reported to increase due to the COVID-19 pandemic because of a decline in physical activity and quality intake during the pandemic (1). Studies cohort retrospective in children ages 5–17 years show an increase in BMI (1.57 times) and the incidence of overweight and obesity (8.7%) in children ages 5–11 years during the COVID-19 pandemic (2). According to data from the 2018 Indonesian Basic Health Research (Riskesdas) survey, one in five children in Indonesia is obese (3). Riskesdas report an incidence of overweight (Z-score BMI/U) in children aged 5-12 by 10.8% (4). The incidence of obesity in children aged 5-12 years in the Special

Province of Yogyakarta (DIY) is higher than the national incidence (10.95%), and Bantul Regency was one district in DIY that had a higher incidence of overweight in children 5-12 years (11.50%) (5).

The problem of obesity in children can have an impact on increasing the risk of non-communicable diseases such as cardiovascular disease, diabetes mellitus, and hypertension (6). The lifestyle that contributes the most to incident obesity in children is excess daily energy intake and low physical activity. Based on the 2018 Riskesdas data, 95.4% of the population over five years have inadequate fruit and vegetable intake, and 64.4% of children have insufficient physical activity (4). Likewise, the data in DIY shows that most of the inadequate physical activity

is found in children of school age (54.37%), and only 10.14% of children ages 5-14 years have adequate fruit/vegetable intake (> five servings/day) (5).

Effective and sustainable intervention is required to prevent obesity in children. One possible alternative to avoid obesity in children is through activity in school (7). Gamification or game-based learning can deliver messages to children (8). The study concludes that gamification affects dietary behavior and nutrition knowledge in a positive manner (9). However, gamification is new to increasing children's knowledge about nutrition and encouraging healthy eating habits (10). On the side, the necessary increase in the health metabolism child through physical activity will significantly help the growth and development child (11).

So far, this has found limitations related to studies on Indonesia's approach to game-based learning and physical activities to increase children's awareness about healthy lifestyles. Besides that, the strategy nutrition education ever developed previously needs to involve more active role kids. Two-component urgent in preventing obesity is repairing dietary habit and increasing physical activity must walk together (12). This fact underlies the provision of physical activity and nutrition education interventions, which are expected to influence eating habits and increase the duration of physical activity in children. The study aims to determine the effect of physical activity-based nutrition educational games on elementary school children's nutritional status and knowledge.

METHODS

This study uses a quasi-experiment method with a *one-group pretest-posttest with a control design*. The study subjects are elementary school children 8 - 10 years old in SD Kauman for the treatment group (51 children) and SD Putren for the control group (45 children) in Pleret, Bantul, DIY. The sample was conducted by purposive sampling with subject criteria inclusion as student school base 8-9 years old, having no history of chronic diseases, and parents and students signed informed consent. The exclusion criteria were subjects who did not participate until the study ended.

Group treatment accepts physical activity-based nutrition educational games, namely "healthy eating plate" and "healthy food race" for 15 minutes for each game. Each intervention is given once a week for nine weeks with 30 minutes of the program. The nutrition educational game "healthy eating plate" is a team game related to food groups and nutrition intake balanced for children to understand what content they must

plate there every meal. Students collaborate in a group with the relay race to gather food picture cards and put the right food over their plates (staple food, side dish, fruits, and vegetables). When time out (15 minutes), the team who fills in the plate with the correct food group is the winner.

Next, the nutrition educational game "healthy food race" is a team game for children that could differentiate between healthy and unhealthy food. The game started with the child running alternate in one team for taking cards already distributed in the playing area for entry in a basket owned by the team. When time out (15 minutes), the team with card food most healthy in the basket is the winner.

The child's height and weight measurement before and after nine weeks of treatment determines the child's nutritional status based on BMI/U Z-score. Besides, measure the nutrition knowledge before and after nine weeks of treatment using the Completed *General Nutrition Knowledge* Questionnaire modified in Indonesian. Then, nutritional status and knowledge scores were analyzed before and after the intervention using paired sample t-test. While differences in BMI/U Z-scores and nutrition knowledge scores in both groups were analyzed using an independent t-test.

RESULTS

The results in **Table 1** subject characteristics show that most subjects are male in both groups with an average age of 109.51 months or approximately nine years. In addition, most subjects in both groups had mothers and fathers with high school education, mothers worked as housewives, and fathers worked as laborers. The results in **Table 2** show differences in anthropometric data on body weight between pre-post in the intervention group and the control group (p=0.000). However, the intervention group's average weight before and after treatment was 27 kg, which is the recommended average ideal weight according to the 2019 Indonesian Nutritional Adequacy Rate (AKG 2019), after the intervention showed a significant difference (p=0.016) in the intervention group, but not so with the control group.

Table 3 shows that physical activity-based nutrition educational games (30 minutes) for nine weeks had a significant effect on body weight (p=0.004) and nutrition knowledge (p=0.028). Furthermore, the intervention group showed a different enhancement in average actual weight significance (p=0.004), more low (0.43±7.42) compared control group (1.04±1.29). Thus, nine times the physical activity-based nutrition educational games can maintain the average weight of the intervention group at normal at 27 kg according to

the Regulation of the Minister of Health of the Republic of Indonesia in the 2019 Nutritional Adequacy Rate.

Furthermore, the intervention group showed differences in enhancement average nutrition knowledge score, which is significant (p=0.028) taller (2.92±14.80) compared group control (0.11±10.11). After getting nine times physical activity-based nutrition educational games, most subjects in the group treatment can already answer the correct majority of questions. Meanwhile, in the control group, almost half the questions at the end study experienced a declining percentage of correct answers compared to the research's beginning (**Table 4**). More further, **Table 5** shows that the average score knowledge grouping of 39 kinds of food experience enhancement after nine times education nutrition games based. However, after interventions, the staple food and fat group declined the average score. Children find both food groups more difficult to distinguish than food groups such as fruit, vegetables, and protein.

Table 1 . Characteristics of research subjects

Category	Treatment (n=51)		Control (45)	
	n	%	n	%
Sex				
Boys	31	60.8	23	51.1
Girls	20	39.2	22	48.9
Mother's education				
Not school	1	2.0	0	0
Elementary school	8	15.7	6	13.3
Junior high school	17	33.3	9	20.0
Senior high school	21	41.2	25	55.6
College	4	7.8	5	11.1
Father's education				
Not school	0	0	2	4.4
Elementary school	8	15.7	9	20.0
Junior high school	14	27.5	5	11.1
Senior high school	27	52.9	26	57.8
College	2	3.9	3	6.7
Mother's job				
IRT/ no work	28	54.9	26	57.8
Laborer	12	23.5	8	17.8
Employee	3	5.9	4	8.9
Businessman	7	13.7	6	13.3
PNS/TNI/ Polri	0	0	1	2.2
Farmers/livestock	1	2.0	0	0
Father's job				
Not work	2	3.9	2	4.4
Laborer	23	45.1	22	48.9
Employee	10	19.6	9	20.0
Businessman	14	27.5	9	20.2
PNS/TNI/ Polri	2	3.9	3	6.7

Table 3 . Effect of physical activity-based nutritional education games on nutritional status and nutritional knowledge

Variable	Delta mean ± SD	p-value
Weight (kg)		
Intervention	0.43 ± 7.42	0.004*
Control	1.04 ± 1.29	
BMI (kg/m^2)		
Intervention	-0.04 ± 1.29	0.333
Control	0.17 ± 0.64	
BMI/U *Z-scores*		
Intervention	-0.06 ± 0.31	0.437
Control	-0.01 ± 0.27	
Nutrition knowledge		
Intervention	2.92 ± 14.80	0.028*
Control	0.11 ± 10.11	

* significant (p<0.05) by *independent sample t-test*

Table 2. The mean of anthropometric data and nutritional knowledge of the subjects before (pre) and after (post) intervention

Variable (Mean±SD)	Intervention (n=51)		p-value	Control (n=45)		p-value
	Pre	Post		Pre	Post	
Weight	27.28±8.63	27.70±8.88	0.000*	29.89±8.37	30.94±9.24	0.000*
BMI	16.70±3.81	16.66±4.25	0.823	17.48±4.02	17.65±4.26	0.086
BMI/U Z-scores	-0.13±1.61	-0.18±1.75	0.197	0.28±1.69	0.24±1.75	0.428
Nutrition knowledge	54.87±9.51	57.83±14.61	0.016*	53.22±8.88	53.44±10.05	0.884

* significant (p<0.05) by *paired sample t-test*

Table 4. Percentage of nutrition knowledge correct answers

Question	Answer correct (%)			
	Treatment (n=51)		Control (n=45)	
	Pre	Post	Pre	Post
How should food below this consume?				
1. Fruit	66.7	58.8	57.8	57.8
2. Sweet food and beverage	60.8	60.8	46.7	55.6
3. Vegetables	70.6	56.9	62.2	71.1
4. High-fat foods	41.2	49.0	71.1	53.3
5. Processed meat	51.0	43.1	28.9	35.6
6. Salty food	33.3	39.2	51.1	46.7
7. Water	88.2	86.3	91.1	86.7
How many fruit and vegetables portion per day for consumed?	31.4	19.6	22.2	15.6
Which fat should be consumed the least?				
1. Unsaturated fat	37.3	54.9	44.4	33.3
2. Trans fats	51.0	56.9	48.9	40.0
3. Saturated fat	39.2	31.4	22.2	37.8
How many times a week do you eat breakfast?	56.9	66.7	73.3	46.7
What should be on your plate every day?				
1. Staple food	78.4	98.0	66.7	77.8
2. Vegetable side dishes	52.9	94.1	40.0	46.7
3. Animal side dishes	60.8	98.0	48.9	62.2
4. Fruits	76.5	100.0	55.6	64.4
5. Vegetables	72.5	100.0	80.0	80.0
6. Milk	35.3	78.4	44.4	46.7
7. Water	17.6	31.4	20.0	24.4
8. Sweet drink	74.5	96.1	84.4	80.0
Which food has the most trans fat (bad fat)?	11.8	33.3	17.8	33.3

Table 5. The mean of nutrition knowledge correct answers

Question	Mean±SD			
	Treatment (n=51)		Control (n=45)	
	Pre	Post	Pre	Post
Do you think these foods and drinks contain high or low sugar? (5 types)	2.41±1.19	2.49±1.14	2.62±0.96	2.67±0.98
Do you think these foods contain high or low salt? (5 types)	2.24±1.18	2.51±1.26	2.27±0.97	2.33±1.26
Do you think these foods contain high or low fiber? (5 types)	2.29±1.33	2.33±1.38	2.18±1.13	2.33±1.17
Are these foods a good source of protein? (6 types)	2.96±1.25	3.02±1.27	3.20±1.06	2.84±1.04
Which food here's included in the food staple? (5 types)	3.51±1.01	3.41±1.24	3.24±1.31	3.18±0.98
Are these foods a good source of fat? (6 types)	3.55±1.30	3.16±1.67	3.38±1.23	3.16±1.36
Which processed or ultra-processed foods should be avoided because they are high energy and low fiber? (7 types)	4.18±1.47	4.33±1.71	3.73±1.25	4.04±1.61

DISCUSSIONS

The results of this study indicate that physical activity-based nutrition educational games (total duration of 30 minutes) for nine weeks can improve nutrition knowledge and maintain the weight of children aged nine years. The results of a systematic review and meta-analysis report that gamification *or* game-based learning positively affects dietary behavior and nutritional knowledge (9). Several studies conducted on elementary school students showed that a game-based learning approach in nutrition education could increase nutrition knowledge, improve eating and drinking habits, and

have a positive attitude toward games (13). Therefore, combining physical activity interventions and providing nutrition education will be more effective in ensuring the success of the nutrition improvement program for elementary school children. The results of research on short-term and long-term effects related to nutrition education interventions in children in China concluded that nutritional improvement in children could be maximized by providing a combination of exercise and nutrition education interventions. Exercise intervention has a better short-term effect, while nutrition education has a better long-term effect (11).

This study used two nutritional education games based on physical activity, namely "healthy eating plate" and "healthy food race". The focus of game content in this study is in line with the ongoing campaign from the Ministry of Health, which combines the national program "Tumpeng Gizi Seimbang" and the "Isi Piringku" campaign. This study used a game-based gamification learning design to ensure that children learn important nutritional information with motivation and engagement (10). When compared to educational methods through traditional methods, which only provide one-way information, active participation of children in nutrition education is very important to teach exciting and effective ways of transferring knowledge (10). Games can also increase children's courage to explore new healthy foods and eat less unhealthy snacks (13).

Physical activity-based nutrition education game intervention "healthy eating plate" and "healthy food race" in this study is more attractive to children, because there is a combination of active involvement (interactivity), overcoming challenges, making choices, teamwork, strategic thinking, and direct feedback to increase children's knowledge. In addition, the potential game-based learning for nutrition education can help children learn complex nutrition concepts through direct experience of situations. Games provide an exciting place to engage participants and increase nutrition knowledge and dietary behavior change (14). Previous studies support these results, which recommend adopting gamification to improve cognitive and physical benefits for children (15).

In a gamification system, the game's core elements are embedded in the desired activity to involve and motivate players to make behavior changes (13). Intrinsically motivated behavior tends to be maintained for longer than extrinsically controlled behavior, which requires constant reinforcement from others (e.g., rewards, etc.) (16). The promotion of healthy active behaviors should begin early because behaviors learned in youth are more likely to persist (17). A school is where children spend half an hour of their productive time and consume at least a third of their daily calories. Therefore, nutrition education in the school setting offers a vital opportunity to implement early health promotion programs to produce effective changes in the family environment (18). Studies have proven that school health promotion programs consistently positively impact nutrition knowledge, choosing healthy foods when eating at school, nutritional self-efficacy, and willingness to try fruits and vegetables (19).

This study provides a combination intervention of nutrition education and physical activity in the form of a game that can increase nutritional knowledge to motivate children to have healthier eating habits and maintain a normal weight. Thus, the gamification method is an educational strategy that can maximize children's participation while providing information; it needs to be used more so that the education provides increased knowledge and motivates changes effectively in children's behavior.

CONCLUSIONS

Physical activity-based nutrition educational games (30 minutes) once a week for nine weeks affect increasing nutrition knowledge and maintaining normal weight in elementary school children aged nine years. Game-based nutrition education can be applied at the school level through sports lessons to give students the experience of learning fun and adequate-intensity activities to benefit health.

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