THE EVALUATION OF NUTRITION EDUCATION IN CHILDREN: SCOPING REVIEW 2013-2023

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ABSTRACT

Introduction: Children's growth and development are greatly influenced by what food they consume because children who do not receive adequate nutritional food for a long period of time can have growth and developmental disorders. One of the factors causing nutritional problems is less knowledge about nutritious food, so education regarding nutrition and health for children is highly needed. It is expected that nutrition education media can facilitate the delivery of information to children. The aim of this literature review is to present an overview of the use of media for nutrition education in children. Method: the design of this study used a *scoping review*. The *Database* publication used *Pubmed, Proquest, Scopus, ScienceDirect,* and *Google Scholar* from 2013 to 2023. The article search strategy used keywords "Children" OR "Child" AND "Nutrition education" OR "Intervention." The inclusion criteria for this study include the children population, the educational or nutrition education variable, and the type of publication including *randomized control trial, longitudinal, single-blinded, pre-experimental quantitative, user-centered, single group intervention, two groups, nonequivalent experimental control group, quasi-experiment*, and qualitative. Result: There were 33 articles that met the inclusion criteria. Most of them were studies with a randomized control trial design. The result of the literature review found that nutrition education using lecture or teaching methods, demonstrations, use of print media, game methods, and physical activity methods can significantly increase knowledge about balanced nutrition in children. There was a significant increase in knowledge after children were given intervention in the form of nutrition education. Conclusion: The use of media in nutrition education can make it easier to convey information to children. Educational media, as a tool in delivering nutrition education to children, has been proven to increase children's nutritional knowledge

Keywords: School age children, Nutrition Education, Media, Nutrition Education.

INTRODUCTION

The success of development in a nation is determined by the qualified human resources that includes human resources with tough physic, strong mental, excellent health, and a good level of achievement (Kartini et al., 2017). Good nutritional status is one of the determining factors for the success of health development, which is basically an inseparable part of overall national development. Children under five, school-age children, and pregnant women are nutritionally vulnerable groups that really need special attention because of the negative impacts they suffer from malnutrition (Ministry of Health, 2018).

Development of good health starts from an early. One of which is at school age. School age is a transition period from child to adult. This occurs quite rapidly in mental, physical, and emotional growth during this period (Amrah, 2013). School-age children in Indonesia are one of the most vulnerable populations in terms of nutrition. Undernutrition and excess nutrition in children will have a negative impact on a country's growth potential (Nuryanto et al., 2014). Children who do not get adequate nutrition over a long period of time can cause problems relating to the child's growth and development, such as wasting, stunting, and the development of mental disorders. Many factors cause malnutrition case (Nugrahaeni, 2018)

Children who lack sufficient nutritional intake will most likely have a decreased immune system that makes them susceptible to infectious diseases which can affect their appetite and absorption of nutrients that lead to malnutrition. Children who often have infectious diseases and malnutrition will easily experience growth and development disorders at their age that will affect the level of health and intelligence as well as the child's productivity in the subsequent growth period (Istiyani & Rusilanti, 2013)

Based on data from WHO and UNICEF (2021), It is globally estimated that 74% of all child deaths are related to malnutrition which makes children vulnerable to disease. Meanwhile, children in Indonesia have quite complex nutrition. Based on data from the Ministry of Health (2022), nationally the nutritional status is 10.8% obese and 8.8% very obese, while the prevalence of children who are thin reaches 7.2% and very thin 4.0%. This problem needs special treatment, considering many negative impacts that can be caused, such as the higher risk of obesity and non-communicable diseases related to diet such as diabetes mellitus and cardiovascular disease, and can also lead to death. Furthermore, malnutrition in children has an impact. Children have hard concentrating, feel inferior, and decreased learning achievement (Nuryanto, 2014)

Various nutritional status problems are caused by diverse factors. Nutritional problems are mostly caused by economic problems, lack of understanding about nutrition, unbalanced menus, and understanding about health (Muhajir et al., 2023). Nutritional problems generally occur due to parents' lack of understanding regarding children's nutritional needs and additional nutritious food. Parents' Knowledge and understanding, especially mothers, regarding balanced nutrition is very important, considering the contribution of mothers in the family as food managers. If mothers do not understand balanced nutrition, they tend to serve nutritionally unbalanced food that doesn't meet their needs (Yuliantini, 2015)

One effort to create an understanding of balanced nutrition for children is providing nutrition education. Nutrition education is an educational approach to improve children's understanding and attitudes towards nutrition. Education carried out using the media will make it easier and clearer for children to receive and understand the material provided. Apart from that, the media can also help provide education in terms of transferring the material (Safitri, 2016)

So far, many children do not understand balanced nutrition in everyday life, nutrition education is provided for children through various communication media to make them understand and apply balanced nutrition in everyday life. Education on balanced nutrition from an early age is very important to change people's behavior, especially for school-aged children, to increase their awareness which can improve individual attitudes about nutritional intake. Thus, it is necessary to provide education to children regarding nutritional knowledge and health. The education for children must be interesting to make the information transfer well received. Therefore, providing education requires appropriate learning media as an intermediary. Based on this background, it is necessary to provide education that can be carried out using certain educational techniques and media for nutrition education in children. This research aims to present an overview of the use of various types of media in education or nutrition education for children.

Research Method

This research uses a scoping review design, which is a method used to identify literature in depth and comprehensively which can be obtained from various sources with various research methods and is related to the research topic. The sources of information used in this

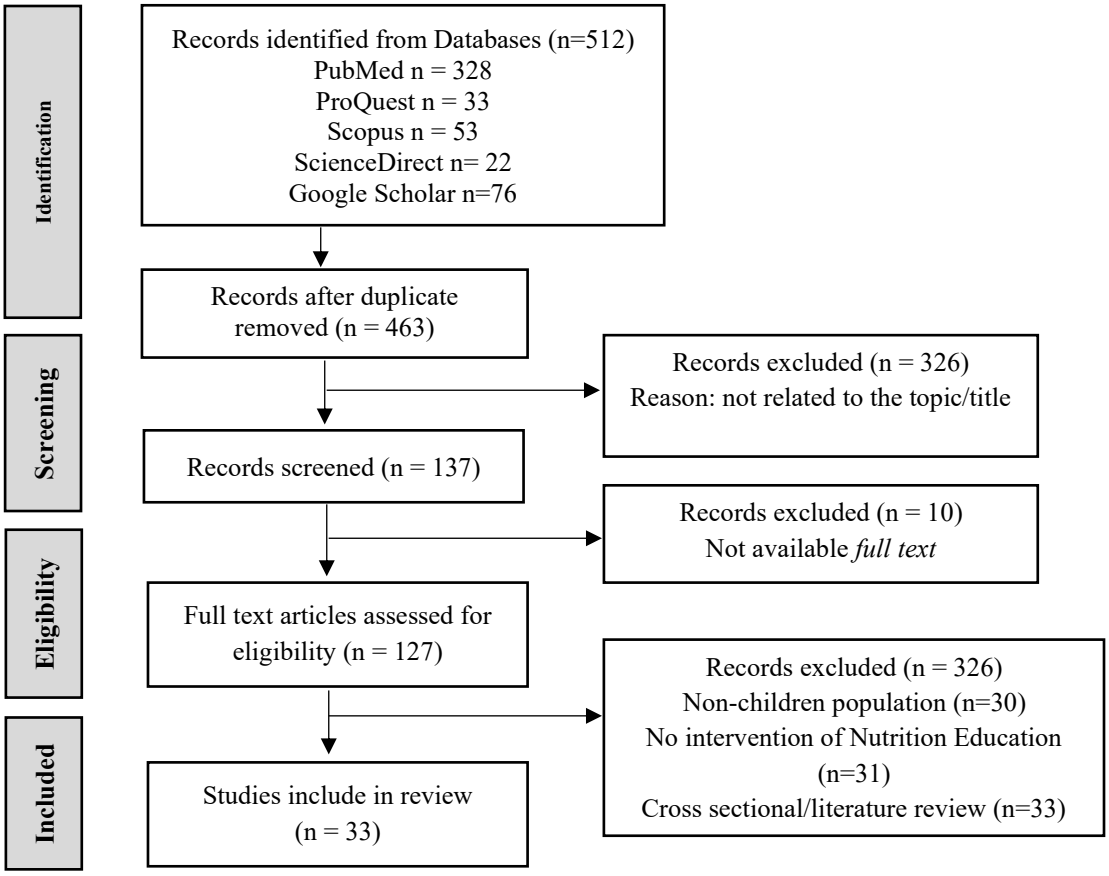
research are five publication databases Pubmed, Proquest, Scopus, ScienceDirect, and Google Scholar with a publication time range from 2013 to 2023.

Criteria of Inclusion and Exclusion

The inclusion criteria used in this scoping review were determined using the PICOS format, namely Population (Children, not autism, not cerebral palsy), Interventions (Nutrition Education or Nutrition Intervention), Comparison (-), Outcomes (-), Study Type (Randomized control trial, Single group pretest-posttest, longitudinal, single-blinded, a pre-experimental quantitative with pre-test and post-test, user-centered design, single group intervention with pre and post-test, a two-group design with one pretreatment assessment and two post-treatment assessments were employed, a nonequivalent experimental control group design, quasi-experiment, and qualitative). Exclusion criteria include articles published before 2013. The language used is not English and the article is not available in full-text.

Searching Strategy

Searching for articles in electronic databases uses keywords and Boolean operators (AND, OR NOT, or AND NOT) which are used to make searching easier. The search strategy was defined as "Children" OR "Child" AND "Nutrition education" OR "Intervention". Keywords in this scoping review are adjusted to the Medical Subject Heading (MesH). Based on search results using these keywords, the detail of 512 published articles from five databases concludes Pubmed 328 articles, Proquest 33 articles, Scopus 53 articles, ScienceDirect 22 articles, and Google Scholar 76 articles. There are 49 similar articles (duplicates) so the remaining are 463 articles. A total of 326 articles were excluded because they did not match the topic or the research title, leaving 137 articles and 10 articles were excluded because the full text was not available. The selection was carried out based on population inclusion criteria (30 articles were excluded), intervention (31 articles were excluded), and study type (33 articles were excluded) so that 33 articles were obtained that met the criteria.



Picture 1. Diagram of Literature Review Prism Flow

RESULTS AND DISCUSSION

Based on the result of a literature review of 33 articles, it was found that most of the research was conducted in the United States of America (USA), where there were 11 articles (33%) that conducted research in the USA. Each has 3 research articles (9%) conducted in China, Italy, and Mexico. Each has 2 research articles (6%) in Spain and Iran. The remaining has 9 research articles (28%) in various countries. Most articles reviewed were researches with a randomized controlled trial design, namely 18 articles (55%), 2 articles each (6%) with quasi-experiment, longitudinal, and non-random clinical trial research designs, the remaining 9 articles (28%) with other research designs such as two groups, single-blind, nonequivalent experiment, and others.

Nutrition education methods used as the intervention in the research in articles that have been reviewed include lecture or teaching methods, demonstration methods, methods using print media (such as brochures, booklets, posters, and handbooks), game methods, and physical activity methods that can increase knowledge about balanced nutrition in children. Apart from print media, other media such as audio-visual or video are also used as the intervention in several studies that have been reviewed. The following is a summary of the results of the literature review of the 33 selected articles presented in Table 1.

Table. 1 The Summary of Selected Content Analysis Result (n=33)

No	Article	Writer	Country	Design	Subject	Media	Detail	Instrument	Result
1	Classroom Nutrition Education Combined With Fruit and Vegetable Taste Testing Improves Children's Dietary Intake	Abby Gold, et.al (2017)	North Dakota, USA	Randomized controlled trial	662 students in grade 3	Class of Cartoon role play	The teacher conducts roleplay for 45 minutes to one hour for 7 weeks	Pre- and post-intervention surveys using validated Physical Activity and School Nutrition questionnaires	Students with access to FFVSP consumed more fruit ($p<.01$) and vegetables ($p<.0001$). Students who took the FFVSP and GWWFV using a taste test consumed more fruit and vegetables ($p<.05$) compared to students who took the FFVSP and GWWFV without a taste test, along with the control group.
2	School-Based Nutrition Education Intervention Using Social Cognitive Theory for Overweight and Obese Iranian Adolescent Girls: A Cluster Randomized Controlled Trial	Mohammed Bagherniya, et.al (2018)	Iran	Randomized controlled trial	172 overweighted and obese students	Workshop and seminar: workshop on cooking, food industry visit, SMS, newsletter, telephone, consultation session	Practical nutrition workshop and interactive seminar twice a month for students (14 sessions, each session takes 60 minutes), once a month for their parents (seven sessions, each session takes 60 minutes), and four sessions (each session takes	Condition of Weight, Height, and Waist (WC), Psychological Questionnaire Regarding Social Cognitive Theory (SCT)	After 7 months, the mean BMI and WC were reduced in the intervention group from 29.47 (4.05) to 28.5 (4.35) and from 89.65 (8.15) to 86.54, respectively (9.76). However, compared to the control group, they were not statistically significant (p values 0.127 and 0.504, respectively). In the intervention group, nutritional behavior, and most psychological variables (self-efficacy, social support, intention, and situation) were improved to support the research and were significant

							60 minutes) for their teachers		compared to the control group (p<0.05)
3	Short-Term and Long-Term Effects of a Combined Intervention of Rope Skipping and Nutrition Education for Overweight Children in Northeast China	Ming Hao, et.al (2019)	China	Randomized controlled trial	229 students with an age range between 9 and 12 years	textbook, lecture	Presentation delivered by the local nutritionist. 45-minute lecture on nutrition education once a week for 2 months (8 lectures, total 6 hours)	BMI (kg/m2), Chinese Food Frequency Questionnaire, guest according to textbook	In both boys and girls, BMI decreased significantly in all three groups post-intervention compared to the previous one (P<0.05). Nutrition knowledge test scores increased significantly after the intervention (40% to 82%) in girls and boys in the 2 groups (N and EN) who attended nutrition education classes (P<0.05).
4	Nutritional Intervention to Improve the Quality of Lunchboxes Among Mexican schoolchildren	Glenda Díaz-Ramírez, et.al (2016)	Mexico	Randomized controlled trial	943 students (students of grades two and six with an age range of 8–12 years)	Flyers, letters, and posters	Parents and teachers are also asked to put up posters in their kitchens and strategic places in the school where they can be seen by parents and children.	BMI (kg/m2) is the Food portion estimated and calorie, fat, saturated fat, protein, and sugar contents were also calculated.	After the intervention, 19 % of children given IG met the criteria for an adequate lunch box, compared to 10 % of children given CG (p=0.002; Table 2). The total fat content in IG lunch boxes is lower than CG (p=0.003)
5	The effects of a nutrition education curriculum on improving	Sara A Schmitt, et.al (2018)	United States of America	Randomized controlled trial	132 Students in Grade 2	Teaching Intervention	The teacher in the intervention class applies six-week (two	A brief survey about nutritional and health knowledge	Children in the intervention condition showed significantly higher scores on the nutrition and health survey (β=0·47, P=0·001)

	young children's fruit and vegetable preferences and nutrition and health knowledge						subjects per week)	as well as a direct evaluation of fruit and vegetable preference	and showed a greater preference for fruit and vegetables at post-test than of the control group (β =0·19, P=0·003).
6	Effects of Physical Activity and nutritional intervention in overweight and obese children through an educational and recreational camp	Suliane Beatriz Rauber, et.al (2018)	Brazil	Non-random clinical test	24 children with an age range of 9-12 years old	Camp	KIDS activities for 5 days with a professionally trained team. KIDS offers educational activities (through games and other non-sedentary strategies), daily thematic intervention, and discussion on healthy nutrition, physical activity, and stress management. After 5 days at KIDS, children and their parents	Body mass (kg); height (cm); waist circumference (WC), hips and arms; waist to height ratio (WSR); body mass index (BMI) (kg/m2(-1)); body fat percentage (%BF); To evaluate PAL and SB, a semi-quantitative food frequency questionnaire for children was used	After the follow-up, 25% of children were active (>1500 and <3000 Metabolic Equivalent of Tasks per week). In contrast, the number of sedentary children (<600 Metabolic Equivalent Tasks per week) decreased by 15%, and less active children (600–1500 Metabolic Equivalent Tasks per week) increased by 15%. Leisure-time physical activity levels increased significantly throughout weekdays (26.0%) and weekends (14.1%) after the follow-up compared to before camp. Sedentary behavior showed a significant decrease of 177.14 minutes and 41.43 minutes on weekdays and weekends, respectively. Before the camp, consumption of sugar and sweet foods was uncontrolled (100% inadequate), and after the

							attend FOU which is planned for 3 months		intervention, 58.4% of children began to consume these foods in a balanced manner.
7	Food, Health, & Choices: Curriculum and Wellness Interventions to Decrease Childhood Obesity in Fifth-Graders	Pamela Ann Koch, et.al (2019)	New York, USA	Randomized controlled trial	1159 students in grade 5	Teaching intervention	The curriculum is 23 science lessons based on social cognitive theory and self-determination, replacing the 2 mandated units. Health is class food and physical activity like Break Dance	Anthropometric measurements; 6 behaviors related to energy balance and 8 factors of theory-based determinants of behavior change (via questionnaire)	Obesity showed no change. In terms of behavior, there was a negative curriculum intervention change in physical activity (P= 0.04). The health intervention resulted in positive changes in sugar-sweetened beverage frequency (P= 0.05) and size (P= 0.006); size of processed packaged snacks (P= 0.01); candy frequency (P= 0.04); well-baked food frequency (P= 0.05); and fast-food frequency (P= .003), size (P= .01), and food combinations (P= .002). Theory-based determinants show no change.
8	Improving dietary diversity of school adolescents through school-based nutrition education and home gardening in Jimma Zone:	Dessalegn Tamiru, et.al (2016)	Ethiopia	Quasi experiment	1000 school teenagers with an age range of 10 to 19 years old	(Peer-led health education (role play); school media (audio tape recorder, Gpass); health club (role-	In total, the intervention was conducted for 8 months	The survey Questionnaire of Ethiopia's demography and health; Questionnaire of individual dietary diversity	There was a significant increase in the proportion of school children consuming a diversified diet among the intervention group from 34.8% at the beginning, 65.6% at mid, and 74.7% at the end (pb0.001). In the control group, there was no change from the midline (49.4%) to the final line (48.8%), although there was a

	Quasi-experimental design					playing, storytelling, debate, drama, and audiovisual activities)			change from the final line (32.1%) to the midline (49.4%). Significant differences in dietary diversity intake were observed between the intervention and control groups at the midline (F = 5.64, p = 0.042) and the final line (F = 5.85, pb0.001) surveys. Being in an intervention school (OR = 2.55 [1.55, 3.50]), male (OR = 1.75 [1.91, 2.56]), and having a farmer mother (OR = 2.58 [1.01, 6.87]) were independent positive predictors of diversification dietary intake. However, having a mother who attended secondary school was inversely associated (OR = 0.25 [0.06, 0.97]) with consuming a diverse diet.
9	An After-School Cultural and Age-Sensitive Nutrition Education Intervention for Elementary Schoolchildren	Bong Nguyen and Mary W. Murimi (2017)	Texas, USA	Non-random clinical test	50 students	Cooking demonstrations, food-related games, and food-tasting	This program is offered as a weekly after-school program for 3 months. The intervention had 2 components: classroom-based	Questions to assess changes in nutrition knowledge and SE were obtained from a questionnaire developed by the Team	A significant increase (P<0.001) in the mean of nutritional knowledge was found after the intervention (pretest: mean,14.3; SD, 5.3; posttest: mean, 18, SD,6.4). Specifically, knowledge scores regarding food sizes and labels increased significantly (P<0.001) after the intervention (Table 2). SE

							nutrition education and a cooking demonstration. Each of these took approximately 45 minutes.	Nutrition program, an initiative of the USDA Food and Nutrition Service	scores associated with consuming low-fat dairy foods and finding portion sizes from food labels increased significantly (P<0.05) after the intervention
10	Exposure to a multi-level multi-component childhood obesity prevention community randomized controlled trial: patterns, determinants, and implications.	Angela Cristina Bizzotto Trude, et.al (2018)	Baltimore AS	Randomized controlled trial	85 low-income urban youth and their caregivers.	poster, Flyers, Education Display, and Prizes	The exposure of three different intervention components (corner restaurant/restaurant, social media/text messaging, and the nutrition education organized by teenagers) was assessed in the education through post-intervention interviews engaging 385 low-income urban youth and their caregivers	Exposure scores were generated based on the self-reported display of BHCK material	Mean intervention exposure scores were significantly higher for intervention compared to youth as the comparator (mean 1.6 vs. 0.5, $p < 0.001$) and caregivers (mean 1.6 vs. 0.6, $p < 0.001$). However, exposure scores in both groups were low and 10% of the comparator group experienced moderate exposure to the intervention. For each 1-year increase in age, there were 33% lower odds of being highly exposed to the intervention (odds ratio 0.77, 95% confidence interval 0.69; 0.88) in unadjusted and adjusted models controlling for adolescent gender and household income.

11	Using Skin Carotenoids to Assess Dietary Changes in Students After 1 Academic Year of Participating in the Shaping Healthy Choices Program	Lori M. Beccarelli, et. Al (2017)	California	Single group pretest-posttest with self-selection	Students (n = 30) from Grade four	teaching interventions; cooking demonstrations; bulletin; lunchroom installments	Nutrient Curriculum presented by a SHCP teacher.	anthropometry; FFQ Block 2004 for students with age range 8–17 years	Carotenoid intake was reported to decrease by 1.5 mg (P=0.05) and skin carotenoids decreased by 2,247.9 RRS intensity units (P=0.04). Changes in reported intake correlated with changes in skin carotenoids (r=.43; P=.02)
12	A theory-based randomized controlled trial in promoting fruit and vegetable intake among schoolchildren: PROFRUVE study	Maria Arrizabalaga-López dkk (2020)	Spain	cluster randomized controlled community trial	192 students are divided into 8 classes (Class 3 and 4) between 7-10 years	Worksheet Poster, Lecture	Teacher training for 1.5 hours for material briefing. The intervention group received lessons every 15 days. Audio-visual presentation from a nutritionist, then worksheets for students and families, diary, FV's folder (video),	Data of Demography data and self-administered 7-day food record	FV intake increased significantly in the intervention group (+ 0.45 portion/day; 95% CI 0.17–0.74; p = 0.001) but not in the control group (+ 0.01 servings/day; 95% CI − 0.20–0.22; p = 0.409). Long-term measurements showed that 1 year after the intervention was completed, the intervention group maintained its effect (+0.52 portions/day from the beginning; 95% CI 0.22-0.78; p = 0.003).

							album, and stickers.		
13	Nutrition education improves knowledge and BMI-for-age in Ghanaian school-aged children	Annan et al (2021)	Ghana	longitudinal school-based intervention study.	433 children from 10 schools aged 9-13 years	PPT presentations (pictures and videos), field practice games (matching pictures with food), brochures, cards and posters	Cards were used to demonstrate food. Demonstration using cards and PowerPoint presentations (images and videos). Students play games using cards to match food with pictures.	Data of Demography, Food and Agricultural Organization (FAO) and Knowledge, Attitude, and Practice (KAP)	PA and nutritional knowledge increased in all groups (P<0.001). The highest increase was among those who received both interventions (31.0%), followed by the nutrition education group (29.8%), and least frequently, the control group (19.1%). Overall, BFA increased by +0.36, from baseline (-0.26) to end of intervention (+0.10, P<0.001). Within groups, the nutrition group (+0.65, P<.001) had the highest improvement, then, both the intervention group (+0.27, P<.001), the PA group (+0.23, P<.001) and finally, the control group (+0.18, P=0.001).
14	Effect of a multi-disciplinary program on anthropometric and biochemical parameters in obese and overweight elementary	Salahshoornezhad, et al (2022)	Iran	Randomized clinical trial	62 female students aged between 9-12 years	Smartphone games, and Cognitive Behavioral Therapy	Three stages of activities are given to the intervention group which concludes NE uses smartphones, psychological training uses	Data of Demography, The Dutch Eating Behavior Questionnaire, Children Depression Inventory	The intervention group showed more promising results in reducing body weight, waist circumference (WC), hip circumference (HC), total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), triglycerides (TG), and FBS compared to the intervention group. intervention. control

	school girls: A randomized clinical trial						CBT, and physical activity programs using aerobics.		group (P < 0.05). In addition, the MET and DEBQ scores in the three sections of emotion, arousal, and restriction were better in the intervention group than in the control group (P < 0.05). However, there were no significant differences between groups regarding the results of serum leptin and waist-to-hip ratio (WHR; p > 0.05)
15	Nutrition Education Intervention Increases Fish Consumption among School Children in Indonesia: Results from Behavioral-Based Randomized Control Trial	Mahmudiono, et al (2020)	Indonesia	randomized control trial	104 students of grades 4 and 5 aged between 10-12 years	The booklet contains (an infographic, comic, book recipe), a lecture, interactive games	The intervention group received 6 NEs which focused on caring for fish ponds and eating fish together at school. Comic containing the benefits of consuming eel fish. The infographic explains anemia.	Data of Demography, Children's Knowledge of and Attitudes towards Fruit and Vegetables, MyPlate Indonesia	.Significant increases in mean delta and effectiveness were observed in attitude, subjective norm, perceived behavioral control, intention, knowledge, and fish consumption (p < 0.001). A 3-month nutrition education intervention based on the theory of planned behavior significantly increased fish consumption in children in elementary school.
16	Preliminary Results of the Planet Nutrition	Ramírez-Rivera, et al (2021)	Mexico	randomized control trial	41 students of grade 5 SD aged 9	Handbook (Planet Nutrition), Lecture,	Students receive 1 hour of material every week	Data of Demography, Food frequency	At week 9, no significant difference was found between the intervention and control groups in change in BMI z-

	Program on Obesity Parameters in Mexican Schoolchildren: Pilot Single-School Randomized Controlled Trial				to 12 years	Videos, flannel boards, sketches, games, and workshop	with a total of 18 meetings. Students receive a handbook with 26 topics regarding nutrition and health. To make the class more entertaining and comprehensive, media in the form of videos, flannel boards, sketches, and games were used.	questionnaire, Nutrition knowledge	score (−0.11, 95% CI −0.23, 0.01). Significant differences were observed in several secondary outcomes: body fat percentage (−1.72, 95% CI −3.42, −0.02), waist circumference (−3.45, 95% CI −5.55, −1.36), physical activity (0.44, 95% CI 0 .01, 0.88) and nutritional knowledge (1.15, 95% CI 0.27, 2.03). Summer vacation had a negative impact on BMI z-scores in both groups and reduced the observed difference between groups at 9 weeks (−0.07, 95% CI −0.22, 0.07). The Planet Nutrition program showed beneficial effects on several obesity and lifestyle parameters in the short term.
17	Impact of a Behaviourally focused Nutrition Education Intervention on attitudes and Practices Related to eating habits and activity levels in	Moitra P, Madan J, Verma P. (2021)	India	randomized control trial	518 students in grades 6 and 7 aged 10-12 years	Activity book, poster, video, games. Presentasi, crossword puzzles, lecture.	The intervention group received weekly classes on the NE topic and 3 parent education sessions in 12 weeks. Each class is 50-60 minutes.	Data of Demography, Knowledge, Attitude, and Questionnaire Practice.	The intervention group reported mean improvements in knowledge (39·3%), attitudes (7·3%), diet (9·6%), and activity practice scores (9·4%) from pre- to post-intervention. No significant changes were observed in the control group. Significant improvements in scores related to perceived benefits, barriers and self-efficacy, breakfast and vegetable

	Indian Adolescents					Students are given an activity book with the title Eat Right and More Move: A Workbook. workbook.		consumption, and moderate to vigorous activity were observed in the intervention group
18	Implementation and Evaluation of the Abriendo Caminos Program: A Randomized Control Trial Intervention for Hispanic Children and Families	Hanon, et al (2019)	USA	randomized control trial	100 families and children aged 6-18 years old	Lecture, games, scrapbook, food demonstration, Video	Families will participate in group workshops over 6 weeks, with 2 hours of meetings on nutrition education through presentations and combined activities, family health, and physical activity.	Rate your plate dietary assessment tool, bedtime routine questionnaire, physical activity questionnaire	The primary outcome was the prevention of overweight in children. the secondary outcomes include changes in children's eating patterns, particularly consumption of fruit, vegetable, and sugar-sweetened drinks, as well as changes in parents' eating patterns and improvements in family routines. Measures will be collected at baseline, postintervention, and 6 months thereafter
19	The effect of comprehensive intervention for childhood obesity on dietary diversity among younger children: Evidence	Xu, et al (2020)	China	randomized control trial	4846 students aged 7-13 years over 38 Elementary Schools	Lecture, handbook, poster, class meeting	Students are given a handbook about nutrition. Nutrition and health lessons were given to students 6 times or 2 times to	Data of Demography, Dietary Diversity Score, Food Variety Score,	The intervention effect per day of the comprehensive intervention group was 0 (95% Confidence Interval (CI): 0, 0.1; p = 0.382) on DDS9, 0.1 (95% CI: -0.1, 0.2; p = 0.374) on DDS28 and 0.1 (95% CI: -0.1, 0.3; p = 0.186) on overall dietary FVS, namely 0.1 (95% CI: 0, 0.1; p < 0.001) on DDS9, 0

	from a school-based randomized controlled trial in China						families and 4 times to teachers and health workers in 2 semesters. Displaying a poster with the title Dietary Pagoda for Chinese people. Two class meetings on the topic of nutrition and health		(95% CI : 0, 0.1; p = 0.168) on the DDS28 and 0.1 (95% CI: 0, 0.1; p = 0.067) on the FVS score of the breakfast diet only. In addition, the CNP group experienced a greater increase in cereals, meat, and fruit, as well as a greater decrease in the proportion of eggs, fish, and dried nuts consumed compared to the control group. Reductions in side effects across dietary diversity and dietary variety were found for the PA intervention, but not only for the NE intervention.
20	Long-term effect of one-time nutrition education in school on nutritional knowledge of early school-aged children	Chojnacka A, Górnicka M, Szewczyk K (2021)	Poland	Longitudinal	76 Elementary school students in grades 2 and 3 with an age range of 7-10 years	Lecture, singing, culinary workshop, computer-based display	NE lecturer took 2 hours per class using talks and exercises in the class. Additional lectures include guesswork and singing	Data of Demography data and nutritional knowledge with a proprietary, self-administrated questionnaire	NK levels were assumed to be very good in 47% of respondents before education, 91% immediately after education, and 74% six months after education. From a total of 23.0 points (max.), an average of 18.1 points were obtained in the first stage, 21.1 points in the second stage, and 19.7 points in the third stage ($p<0.001$). soon after NE and six months after, NK levels increased significantly (compared to the first stage), especially on these topics: daily water

									requirements and physical activity recommendations (p<0.001 for both questions)
21	The Effectiveness of the Foodbot Factory Mobile Serious Game on Increasing Nutrition Knowledge in Children	Froome et al (2020)	Canada	single-blinded, parallel, randomized controlled pilot	79 students of grades 4 and 5 with an age range of 8-10 years	mobile game application	The intervention group used the Food Bot Factory game. The control group used My Salad Shop Bar. Play games for 10-15 minutes in 5 days.	Data of Demography, Nutrition Attitude, and Knowledge Questionnaire	Compared to the control group (n = 34), children using Food Bot Factory (n = 39) experienced a significant increase in overall nutritional knowledge (10.3 ± 2.9 to 13.5 ± 3.8 versus 10, 2 ± 3.1 to 10.4 ± 3.2, p < 0.001), and in the sub-scores of Vegetables and Fruits (p < 0.001), Protein Foods (p < 0.001), and Whole Grain Foods (p = 0.040). No significant difference in knowledge was observed in the Beverage sub-score. Food Bot Factory has the potential to be an effective educational tool to support children in learning about nutrition.
22	Effect of the Flipped Classroom and Gamification Methods in the Development of a Didactic Unit on Healthy Habits and Diet in	Gómez-García et al (2020)	Spain	pre-experimental quantitative with pre-test and post-test	Elementary school students in grade 6 aged 11-12 years old	Traditional classroom, Flipped Classroom, Gamification, video, puzzle, reward	There are 5 stages: Stage 0: introduction to the concept of the flipped classroom and gamification; Stage 1: Distribution of pre-test questionnaires; Stage 2:	Demographic data and Student Motivation Survey	It was found that the effect of applying the methodology led to an increase in variables as shown by the post-test result. Thus, the autonomy construct received the highest score, followed by self-regulation and motivation. Response variability was high in many cases, which may infer the presence of outliers in the data distribution.

	Primary Education						development of didactic units on nutrition education and healthy habits begin; Stage 3: starting activities; Stage 4: distribution of post-test questionnaires		
23	Nutrition education and promotion of healthy eating behaviors among Mexican children through video games: design and pilot test of foodratemaster	Espinosa-Curiel et al (2020)	Mexico	user-centered design	60 students with an average age of 9 years	Video games	After completing the pre-test, students are asked to play the FoodRateMaster game which contains 12 game sessions with at least 15 minutes per session. The total time to use the game is 3.5 hours with a period of 45 days.	Demographic data and Food Knowledge Questionnaire	Participants demonstrated an increase in food knowledge from pre-game (mean 56.9, SD 10.7) to post-game (mean 67.8, SD 10.7; P<.001). moreover, there was also reported a greater frequency of consumption of cauliflower and broccoli (P<.001) and corn quesadillas (P<.001). They also showed lower self-reported intake of 10 unhealthy foods, including French fries (P=0.003), sweets and chocolate (P<0.001), sweet soft cakes (P=0.009), and soft drinks (P=0.03). In addition, most parents who answered the parent perception questionnaire agreed that

								their children showed greater interest in explaining why they should avoid some unhealthy foods (67%, 26/39), in differentiating between healthy and unhealthy foods (64%, 25/ 39), and on fruit (64%, 25/39) and vegetable (59%, 23/39) intake. Finally, 14 parents stated that they introduced some changes to their child's diet based on comments and suggestions they received from their child.
24	Giocampus School: a "learning through playing" approach to delivering nutrition education to children	Rosi et al (2016)	Italy	Single-group intervention with pre-and post-test	8165 elementary school children aged 8-11 years	Props and games	Education using a "learning while playing" approach for 3 hours for each class for 3 months. Evaluation of the intervention is based on the results of questionnaires completed by children before and after 3 months of	Third-grade Questionnaire, Fourth-grade Questionnaire, and Fifth-grade Questionnaire	Children's nutritional knowledge increased significantly ($p<0.001$) at all school levels. An integrated "learning by playing" approach, including educational figures, tools, and games, is successful in increasing children's nutritional knowledge. Steady integration of these methods in elementary school can prepare a new generation of citizens and more educated about health-promoting lifestyles.

							participating in the Giocampus Program.		
25	Result of School-based Intervention on Cardiovascular Risk Factors	Hrafn Kelsson et al (2014)	Iceland	cluster randomized control trial with control and intervention group	The research was conducted on 321 7-year-old children in elementary school	Health education / Conventional classes, Homework Assignment Health education / Conventional classes, Homework Assignment	A total of 286 7-year-old children who participated in an integrated and replicable physical activity program increased to 60 minutes in the second year of intervention. In addition, special information is provided about nutrition, parents, teachers, and school food service staff.	Blood tests, cardiorespiratory fitness, nutritional intake, and blood pressure which are measured directly before and after the intervention are carried out.	Fruit and vegetable intake increased significantly by 47% in intervention schools and decreased by 27% in control schools. Fiber intake increased significantly in intervention schools (17%) and not in control schools (7%). Blood pressure, amount of fat, and insulin levels did not significantly change with the intervention carried out
26	The Cost and Cost-Effectiveness of a School-Based Comprehensi	Meng et al (2013)	Guangzhou, China	Multi-center randomized controlled trial	All students met the inclusion criteria (non-	Handbook, pamphlet cartoon, and conventional class	The program is carried out for 2 semesters in 1 academic year with	Demographic data, Daily energy intake, and leisure time of daily	The increases in BMI and BAZ were 0.65 kg/m(2) (SE 0.09) and 0.01 (SE 0.11) respectively in the combined intervention which is significantly lower than in the

	ve Intervention Study on Childhood Obesity in China			boarding, obesity rate at school more than 10%, and school feeding with 50% of students having lunch at school).		interventions that include nutrition education using handbooks and cartoon pamphlets, as well as in the conventional class, 10-minute physical activity intervention using games or gymnastics, as well as combined intervention.	physical activity.	control group (0.82 ± 0 .09 for BMI, 0.10 ± 0.11 for BAZ). No significant differences were found in either changes in BMI or BAZ between the PA intervention and the control, which was the same as in the nutritional intervention. Single interventions have relatively lower intervention costs compared to combined interventions. Labor costs in Guangzhou, Shanghai, and Jinan are higher than in other cities. The respective cost-effectiveness ratios were $120.3 for BMI and $249.3 for BAZ in the combined intervention.
27	Kaledo, a board game for nutrition education of children and adolescents at school: cluster randomized controlled trial of healthy lifestyle promotion.	Viggiano et al (2013)	Italy	Two Group Design with one pre-treatment assessment and two post-treatment assessments was employed	Total Subjects are 3,110 aged 9-19 years from 20 schools in Italy	Game	In the treatment group, games were introduced every week for 20 consecutive weeks. The control group did not receive any intervention.	Adolescent Food Habits Checklist (AFHC), Dietary Questionnaire and BMI z-Score	After 6 months of intervention, the intervention group had a higher score than the control group on AFHC. The BMI z-score was significantly lower than the control group. Kaledo improved nutritional knowledge and dietary behavior over 6 months and had a sustainable effect on BMIz.

28	The use of new technologies for nutrition education in primary schools: a pilot study.	Rosi et al (2016)	Italy	randomized, controlled, school-based intervention with three arms.	145 children were divided into the MT intervention group with educators, the MT intervention group with robots, and the control group.	Game/Permainan, Robot	A total of 58 children received health education with a Master of Taste (MT) and a nutrition educator, 54 children received health education with MT and a Humanoid robot, and 33 children were in the control group without any intervention.	The importance of carbohydrate questionnaire using AF Score	In the intervention group, there was an insignificant change related to nutritional knowledge (with AF Score), namely p = 0.063. The AF score in the intervention group was relatively higher compared to the AF score in the control group.
29	Effects of a food advertising literacy intervention on Taiwanese Children's food purchasing Behaviors.	Liao et al (2016)	Taiwan	Nonequivalent experimental control group design	There were 140 5th grade students aged 10-11 years who were selected from one school randomly and divided	Food advertisement, conventional class	The first group received education from food advertising literacy, the second group received a knowledge-based nutrition education	An outcome evaluation instrument and a Process evaluation instrument	The results showed that, compared to the second group and the control group, the first group showed higher nutritional knowledge, food advertising literacy, and food purchasing behavior post-intervention, but there was no significant increase in nutritional knowledge and food purchasing behavior at 1 month of follow-up.

					into 3 groups.		program, and the third group did not receive any intervention or education.		
30	Effects of the Quest to Lava Mountain Computer Game on Dietary and Physical Activity Behaviors of Elementary School Children: A Pilot Group-Randomized Controlled Trial.	Sharma et al (2015)	Dallas, Texas	Quasi-experimental group randomized controlled trial.	children in grades 4 and 5 of elementary school in Texas.	Games, video games	QTLM was implemented as part of the in-school or after-school program. Recommended game exposure duration was 90 min/wk for 6 weeks.	Demographic data, dietary intake, Nutrition and physical activity habits and related psychosocial mediators, anthropometric measures	children played an average of 274 ± 110 minutes (approximately 4.6 hours) of QTLM over 6 weeks (51% of the recommended dose). Compared to the comparison group, children in the intervention group reported decreased sugar consumption (P=0.021) and higher nutritional attitudes/physical activity (P=0.041) before and after the intervention. There was no significant effect of QTLM on physical activity. However, post hoc analysis showed that higher QTLM exposure and game progress were associated with increased frequency of physical activity (P<0.05).
31	Impact of a nurse-directed, coordinated school health program to enhance physical	Wright et.al (2013)	USA	Randomized controlled trial	Participants included 251 children aged 8–12 years from	Fitness program (physical activity class and nutrition education)	The intervention includes Kids N Fitness, a 6-week program that meets weekly to provide 45	Children and Adolescents Trial for Cardiovascular Health School, Physical Activity and	There was a significant Result for students in the intervention, including for boys with a decrease in watching TV; and girls with an increase in daily physical activity, physical education class attendance, and

	activity behaviors and reduce body mass index among minority children: A parallel-group, randomized control trial				elementary schools in urban, low-income neighborhoods in LA, USA.		minutes of organized physical activity, and a 45-minute nutrition education class for parents and children.	Nutrition Student, and Questionnaire measures physical activity behavior	decreased body mass index z-score from baseline to 12-month follow-up.
32	Manga Comic Influences Snack Selection in Black and Hispanic New York City Youth	Leung, et.al (2014)	New York, USA	Randomized pilot study	Participants were 57 youths aged approximately 8-15 years old who took part in a program with Brooklyn Community Services.	Comic, bulletin	Participants will receive comics and newsletters at random. Then, participants will be offered snacks which are rated based on healthy/unhealthy food choices.	Snack and food selection measured by direct observation	Comic group participants were significantly more likely to choose a healthy snack, compared to the theAttention-control group (odds ratio¼3.6, 95% confidence interval: 1.1–12.1, P¼.04). The Comic group reported increases in self-efficacy (P¼.04) and greater transportation (immersion into media) (P¼.006).
33	The Nexus of Knowledge and Behavior for school-aged children: implementation of Health Education and	Miller et al (2014)	Australia	Qualitative	16 participants from grades 3 to 10 were selected by the class	Conventional class and poster	The Health Education Program (HEP) is carried out in the classroom every week. The Nutritional	The interview was conducted after an 18-month intervention carried out	Results indicated that there was a lack of consistent and accurate student knowledge derived from the Health Education programs. Recommendations include a greater alignment between the NutritionalSymbol System, the plate, and all Health

a Nutritional System	teacher using in-depth interviews	Symbol System (NSS) is used as a project using posters to educate students in choosing food in eating places or in the canteen.	Education Program materials to enhance students ' literacy around informed nutrition-related decisions.

DISCUSSION

Nutrition education is a method and effort to increase nutritional knowledge and eating behavior to create optimal nutritional status (Perdana, Madanijah, & Ekayanti, 2017). Nutrition education can increase nutritional knowledge to encourage students to act and decide on choosing healthy nutritional intake. (Dewantari, Syafiq, & Fikawati, 2020) The educational method employing media is a communication channel tool used to make it easier to convey health messages to children to increase children's knowledge. The media used as the intervention in health promotion education are printed media, electronic media, games media, social media, visual media, audio-visual media, and mixed media (Raodah & Lina Handayani, 2022)

Lecture Method

The lecture method is a way to explain an idea or insight and a spoken message to several groups of people (Tambak, 2014). The lecture method is confirmed to be effective in increasing an individual's knowledge (Koch et al., 2019). Based on research (Schmitt et al., 2018), it was revealed that the lecture method in the intervention was constructed to enhance expected children's food behavior and nutritional and health management. The increased nutritional knowledge can be seen in the children as the participants. It is in line with the research conducted by Trial, Bagherniya, Sharma, & Darani (2018) revealing the result that using nutritional lecture intervention was effective in preventing overweight and obese young women. This is also in line with the research carried out by Beccarelli et al. (2017) showing that providing education using this method was effective in promoting healthy eating patterns.

According to the research constructed by Hao, Han, and Yamauchi (2019), the nutrition education method used was lecturing to give material to the control and intervention groups on nutrition education which took 45 minutes once a week for 2 months. The material presented, regarding exercise intervention and nutrition education or a combination of both, is effective in maintaining body weight for school-aged children. It is in line with the research carried out by Wright, Newman, Norris, & Suro (2013) which explains that providing 45 minutes of physical activity and 45 minutes of nutrition education can reduce Children's body mass index.

The research result conducted by Annan, Apprey, Agyemang, and Tuekpe (2021) explained that there was a significant change in the average score of students' knowledge before and after being given the nutrition education intervention ($p<0.001$). The research involved teachers and children. According to the research from Tamiru et al. (2016), the nutrition education method used in this research was the lecture using pocketbooks, material in the form of power points, posters, videos, and pictures. This is in line with Jáuregui, Portillo, Martínez, Etaio, and Mauleón (2018) who explained that activities begin by providing education and provision, and then the teacher provides the intervention by giving the education to children. Based on the results of this research, it is clear that the intervention program is quite effective in increasing food intake and providing long-term effects. Apart from that, Hannon et al. (2019) stated that parental involvement in meetings about nutrition education provides significant results including changes in eating patterns, especially fruit and vegetable consumption, changes in parents' eating patterns, and the improvement of family routines. This is reinforced based on Piaget's theory of cognitive development describing an effective method concluding visual game-based learning that emphasizes the concepts of schema, assimilation, and adaptation that can improve cognitive function and store information in children's long-term memory.

Demonstration Method

The research conducted by Nguyen and Murimi (2017) showed that nutrition education interventions using demonstration provide a significant positive impact. This was developed by designing a cooking role-play model and then connecting it to classroom-based nutrition education. The result of the study stated that there was a significant increase p (0.001) in the average nutritional knowledge after the intervention. This is in line with Gold, Larson, Tucker, and Strang (2017) who revealed that education through role play for 45 minutes to 7 weeks resulted in an increase in fruit and vegetable intake in grade 3 students.

Educational Method of Printed Media Application

Increasing knowledge in nutrition education requires good educational media to support the success of the educational process. One effort to increase people's knowledge, in general, and school children, in particular, can be conducted using the program of Communication, Information, and Education (CIE). In the CIE program, printed media is more effective in conveying nutritional information and education, because print media is a static medium that prioritizes visual messages and generally consists of several words, pictures, or colorful photos in the form of posters, leaflets, brochures, magazines, modules, and pocketbooks (Arsyad, 2015).

Overall, all the media used in this research resulted in an increase in knowledge before and after the intervention. Based on Cristina, Trude, Kharmats, Jones-Smith, and Gittelsohn (2018), communication material is presented on poster media. This intervention was carried out within three phases in 2 months. The result revealed that the average value of exposure to the intervention was significantly higher for the intervention than children as a comparator with p(<0.0001). In line with Moitra, Madan, & and Verma (2021), increasing participant involvement and interest can use various interactive educational materials such as posters. Based on the result, it was found that the intervention group reported an average increase in knowledge (39.3%), attitudes (7.3 %), and activity practice score (9.4%). When providing the intervention, parents and teachers also need to be involved in putting up posters in strategic places in the school so that parents and children can see (Dı´az-Ramı´rez, Jime´nez-Cruz, & Bacarı´-Gasco´n, 2016).

Based on the research conducted by Mahmudiono, Nindya, Rachmah, and Segalita (2020), there was a significant increase in the average delta and effectiveness observed in attitudes, subjective norms, perceived behavioral control, intention, knowledge, and fish consumption (p <0.001) after carrying out nutrition education using booklet media. The material in the booklet can give an interesting impression to the reader because it has word images with various colorful visuals.

A nutrition pocketbook is a medium for conveying health messages, both in the form of writing and pictures given to children. Based on the research carried out by Ram et al. (2021), providing intervention using pocketbook media provides positive results. This program is designed to include strategies related to achieving positive behavior change, including motivation, risk awareness, perceived benefits of behavior change, barriers to changes, skills, knowledge, and behavior change strategies as well as teaching materials using graphic designs aimed at attracting children's attention. In addition, Meng et al. (2013) stated that the pocketbook intervention has low-cost effectiveness for increasing BMI in school children and has a potential impact on preventing childhood obesity. In contrast to the research conducted by Id et al. (2020), there was no significant effect on overall food diversity and food variety per day. A significant impact is seen in the consumption of several foods, and food diversity. A significant increase in food variety appears at breakfast.

Comics, as learning media, can make children interested and they are able to increase their knowledge significantly. Based on the research conducted by Leung, Tripicchio, and Agaronov (2014), nutrition education using comics about balanced nutrition increases children's knowledge about balanced nutrition in a meaningful way. However, there was a significant difference that comic group participants were significantly more likely to choose healthy snacks, compared to the control group (odds ratio = 3.6, 95% confidence interval: 1.1-12.1, P = 0.04).

Game Method

The school education program is one effort to implement global health intervention simply and effectively to attain broader education. Nutrition education using games is one effort to increase children's knowledge about balanced nutrition. This has been confirmed in research carried out by Salahshoornezhad (2022) showing that education using video games can possibly influence performance in real life. Furthermore, a multi-disciplinary approach to childhood obesity may perform better in most areas than a single-intervention approach in the management of obesity. This is in line with Espinosa-Curiel, Efr, & Lozano-salas (2020) stating that in the initial evaluation, children aged between 8 and 10 years showed an increase in the level of nutritional knowledge and frequency after being given the intervention. In addition, the participant's parents agreed that providing the intervention had a positive effect on their children's attitudes towards several healthy eating behaviors.

Based on research carried out by Sharma et al. (2015), video game intervention is implemented as part of a program at school or after school. The recommended duration of game exposure is 90 minutes/week for 6 weeks. The results obtained from the intervention group reported a decrease in sugar consumption (P=0.021) and higher nutritional attitudes/physical activity (P=0.041) before and after the intervention. In line with the research, computer-based educational games have promising acceptance and initial effects on significantly reducing sugar intake and improving nutrition, physical activity attitudes, and behavior.

These video games have the potential to be an effective digital tool to engage children in nutrition learning, resulting in significant increases in overall nutritional knowledge and in most nutritional knowledge sub-scores. These data suggest wider use of serious games to support the dissemination of healthy eating guidelines and facilitate learning dealing with healthy eating among children in primary schools and home settings (Froome et al., 2020).

Based on research carried out by Viggiano et al. (2014), playing kaledo (*a board game for nutrition education of children and adolescents at school)* can increase nutritional knowledge, improve self-reported dietary behavior, and encourage long-term weight loss. Playing kaledo has a therapeutic effect on BMI Z-Score mediated by increasing healthy eating behavior. In contrast to the research conducted by A Rosi et al. (2016), in educational games using humanoid robots in the intervention group, there was an insignificant change related to nutritional knowledge, namely p=0.063. This is because the effectiveness and validity of the approach to using the robot platform did not increase the child's knowledge. It needed longer intervention to fully understand the potential within a nutrition-based school curriculum framework.

Method of Physical Activity

Physical activity is all activities or body movements consisting of physical education, community activities, and free time activities that can cause muscle activity resulting in

increased energy expenditure. Physical activity is important for physical and emotional health and achieving a normal body weight. Physical activity can balance the calories contained in food with the calories used during physical activity so that you can control body weight. Physical activity during childhood and adolescence can reduce the risk of factors related to the risk of chronic disease (Damayanti et al., 2019). Based on the research carried out by Wright et al. (2013), providing physical activity for 45 minutes and nutrition education for 45 minutes can reduce children's body mass index. This is in line with the research from Alice Rosi et al. (2016) which stated that physical activity intervention using props and activities specifically designed using a learning-while-playing approach can increase children's nutritional knowledge significantly with p (< 0.001).

CONCLUSIONS

Utilizing methods using nutrition education media can facilitate the convey of information among school-age children. Educational media, as a tool in delivering nutrition education to children, has been proven to increase nutritional knowledge using all educational media including lecture media, educational methods, printed media such as posters, leaflets, brochures, comics, pocketbooks, demonstration methods, games methods, and physical activity methods. All research related to the influence of nutrition education using media has always increased children's nutritional knowledge.

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