Research Article

Online Nutritional Education Using Wordwall Game to Improve Knowledge Among Overweight and Obese Children in Palembang

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Abstract

The increasing prevalence of overweight and obesity in school children can be prevented by providing nutrition education to improve their nutrition knowledge. PowerPoint media and online games have improved learning outcomes and increased interest and motivation during online education. This study aimed to analyze the effect of online nutritional education using PowerPoint media, with and without Wordwall Game, on nutritional knowledge among overweight and obese elementary school-aged children in Palembang, from March 6th to 15th, 2023. It followed a quasi-experimental design, using a nonequivalent control group model, and measured pre and post-intervention data. The study utilized a purposive sampling technique, resulting in a total of 108 overweight and obese students aged 10-12, with 54 subjects in each group. Nutritional knowledge data were obtained through structured questionnaires previously tested for validity and reliability. The results of the independent t-test showed a significant difference in the mean scores of nutrition knowledge, with better results observed in the experimental group (p= ≤0.001). This indicates that providing online nutrition education through Wordwall Games and PowerPoint media is more effective in improving six aspects of nutritional knowledge in elementary school children than those who only use PowerPoint slides.
Keywords: *online nutritional education, nutritional knowledge, Wordwall, learning media, obese children.*

Edukasi Gizi secara Daring Menggunakan *Wordwall Game* untuk Meningkatkan Pengetahuan Anak *Overweight* dan Obesitas di Palembang

Abstrak

Meningkatnya prevalensi kelebihan berat badan dan obesitas pada anak sekolah dapat dicegah dengan edukasi gizi untuk meningkatkan pengetahuan gizi. Media PowerPoint dan permainan Wordwall dapat meningkatkan hasil pembelajaran dan minat serta motivasi selama pendidikan daring. Penelitian ini bertujuan untuk menganalisis perbedaan pengaruh edukasi gizi daring menggunakan media Power Point, dengan dan tanpa permainan Wordwall; terhadap pengetahuan gizi pada anak sekolah dasar yang mengalami kelebihan berat badan dan obesitas di Palembang, dimulai dari tanggal 6 sampai dengan 15 Maret 2023. Penelitian ini menerapkan quasi-experimental design, menggunakan model nonequivalent control group, serta mengukur data pra dan pasca-intervensi. Sampel diambil dengan teknik purposive sampling, dan diperoleh total 108 siswa yang mengalami kelebihan berat badan dan obesitas pada usia 10-12 tahun, dengan 54 subjek di setiap kelompok. Data pengetahuan gizi diperoleh melalui kuesioner terstruktur yang sebelumnya telah diuji validitas dan reliabilitasnya. Hasil uji t tidak berpasangan menunjukkan perbedaan bermakna pada rerata skor pengetahuan gizi, dengan hasil yang lebih baik pada kelompok eksperimen (p= ≤0,001). Hal tersebut menunjukkan edukasi gizi daring melalui permainan Wordwall dan media PowerPoint lebih efektif dalam meningkatkan enam aspek pengetahuan gizi pada anak sekolah dasar, dibandingkan subjek yang hanya menggunakan slide PowerPoint.
Kata kunci: *edukasi gizi daring, pengetahuan gizi, Wordwall, media pembelajaran, anak obesitas.*

Introduction

One of the nutritional problems among school-age children is overweight and obesity. According to the World Bank, 87 million (7%) children (10-19 years) globally were obese in 2020, which is expected to continue increasing.[1] A study by Lange et al[2] showed that children aged 6-11 experienced the largest increase in their rate of body mass index (BMI) change during the COVID-19 pandemic. In Indonesia, the prevalence of overweight and obesity in elementary school-aged children (5-12 years old) in 2018 was 20%, which had increased by 20% since 2013.[3] In Palembang, the prevalence of overweight and obesity is high at 19.71%.[4] If not addressed, childhood obesity can lead to health problems and potentially disrupt future human resources.[1]

Studies have shown that childhood obesity is associated with the consumption of ultra-processed food group snacks containing high levels of flour, calories, sugar, fat, and sodium;[5] inadequate consumption of vegetables and fruits as recommended;[6] insufficient intakes of fiber, falling below the Recommended Dietary Allowances (RDA);[7] imbalanced lunch menus in terms of both food types and portion sizes;[8] physical inactivity and sedentary behavior.[9] These improper nutrition-related behaviors were associated with nutrition knowledge. Overweight and obese children in elementary schools were lack sufficient nutritional knowledge, especially regarding balanced nutrition guidelines.[10] Nutritional education has been recognized as a potential factor in improving dietary habits by enhancing children's nutritional knowledge.[11]

In the era of globalization, Information Communication Technology (ICT)-based learning tools for elementary school-aged children have been increasingly used in the classroom.[12,13] Various tools are available to be used as teaching tools, and their potential is also recognized for nutrition education at school. One commonly used ICT-based learning medium is PowerPoint. PowerPoint media has shown effectiveness in improving learning outcomes for elementary school children. However, PowerPoint media can also lead to passive learning experiences if educators include excessive detail, use visually unappealing or boring slides, and overload slides with too much text, thus reducing their readability.[14]

Incorporating game-based learning media following PowerPoint slides is an effective approach to reinforce and practice concepts during the learning process. Game-based learning is utilized to enhance memory capacity, foster problem-solving skills, and facilitate skill development-where learners are motivated by in-game achievements.[15] Game-based interventions promote motivation, enjoyment, and strong performance among learners.[16] ICT has modernized education during the COVID-19 pandemic by offering interactive digital media exercises. A popular educational software used for this purpose is Wordwall.[17]

Wordwall Games is an educational game application available on the web that offers a variety of interactive games and quizzes, serving as a valuable learning resource, media, and engaging assessment tool for students.[18]entertaining learning media game. This study aims to determine the effect of word wall media on student interest and learning outcomes. The research used the experimental method, Quasi Experimental form with Nonequivalent Control Group Design. Determination of the experimental and control classes using a simple random sampling method, treatment in the experimental class using word wall media, and media box questions in the control class. The data collection instrument for pretest-posttest learning outcomes is in the form of multiple-choice questions. Meanwhile, interest in learning was measured using a questionnaire with the Linkert scale. Analysis of learning interest data using the t-test obtained the value of student interest in learning (0.000 <0.05 Numerous studies exploring the use of Wordwall Game in online mathematics learning have demonstrated their positive impact on student learning outcomes. Moreover, these games have been found to enhance student interest and motivation during online learning.[19] Web-based games go beyond merely targeting cognitive aspects of learning outcomes; they also consider motivation and a sense of excitement during the learning process.[20] In light of this, researchers aim to investigate the impact of online nutritional education utilizing PowerPoint and game-based learning media on the nutritional knowledge of overweight and obese elementary school-aged children in Palembang.

Methods

This is an intervention study using a quasi-experimental design with a nonequivalent control group. The intervention involved nutrition education delivered online through the Zoom Meeting application for 3 consecutive days. The control group received nutrition education using PowerPoint slides, while the experimental group

engaged in Wordwall Game sessions after the PowerPoint sessions. The study was conducted from March 6th to 15th,2023.

Wordwall is a web-based application which provides eighteen interactive and printable game templates operated and played on any web-enabled device, such as: a computer, tablet, smartphone or interactive whiteboard. This kind of game can be operated by enrolling the player's name (Figure 1a). There are brief instructions of how to play the game (Figure 1b). The display of each activity and the score depend on a few questions asked (Figure 1c). The appearance of score will be on the screen at the end of the game. Players can click leaderboard to watch the levels of ranks, click show answers to see answer keys, and click start again to repeat the game (Figure 1d).

In this study, the preparation stages of the Wordwall Game involved several steps. Firstly, activity templates (Balloon pop, quiz, group sort, match up, true or false, crossword, categorize,

gameshow quiz, and maze chase) were selected from the Wordwall application. Next, content in the form of text and images was created to suit each type of game. Subsequently, the trial phase of the Wordwall Game took place. Ten activity templates were tested on 10 overweight/obese students of SD Negeri 01 Palembang along with two elementary school teachers and two nutritionists from Primary Health Care (Puskesmas) on February 23rd, 2022. Following the gameplay, participants were asked to evaluate the activity templates using a Google Form questionnaire. Teachers and nutritionists provided feedback on the material and visual appearance of each game. The last stage is media revision. Researchers made improvements to the game's visual appearance on digital devices, such as adjusting text size, image size, and color. Special attention was given to ensuring the game's visual display was clear particularly when played on mobile phones. The aim was to enhance the overall gaming experience and user interface.
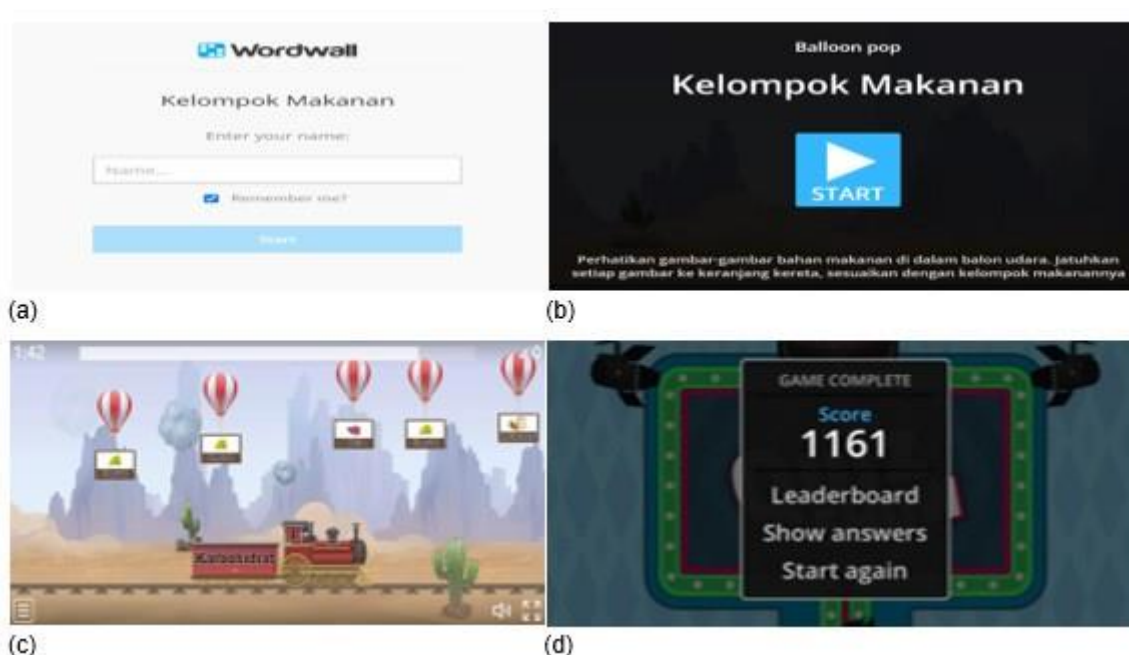

Figure 1. (a) Game Start Screen; (b) Game Instructions; (c) Game Display; (d) Game Completion

The subjects of the study were overweight and obese elementary school students aged 10-12. The sample size was calculated to estimate the improvement in knowledge before and after the intervention with a 5% error and 80% power. Fifty-four students were allocated to each of the control and experimental groups, totaling 108 students for both groups. Subjects were selected using a purposive sampling technique.

The nutrition education material covered six aspects of nutrition knowledge, including food groups,[21] healthy and unhealthy food choices,[11] nutrition guidelines,[22] vegetables and fruits, dietary fiber,[21,23] and food exchange lists.[11,24] These topics were presented in the form of PowerPoint slides and translated into 10 game templates within the Wordwall application. The nutrition knowledge of the subjects was assessed before and after the intervention using

a pre-validated nutrition knowledge questionnaire with a Cronbach Alpha value of 0.667. Statistical analysis was assessed using the Statistical Package for Social Sciences (SPSS) version 26. Data were analyzed using paired t-test, independent t-test, and analysis of covariance (ANCOVA). Activities during

online nutritional education in the experimental group and the control group can be seen in Table 1.

The study obtained ethical approval from the Ethics Commission at Faculty of Medicine Universitas Indonesia with No. Protocol: KET 145/UN2.FI/ETIK/PPM.00.02/2023.

Table 1. Activities in The Experimental and Control Group during Three Days of Online Nutrition Education

Time	Learning Media	Experimental	Control
Day 1	PowerPoint slide	Balanced nutrition - Classification of five types of food - Healthy and unhealthy food - Balanced nutrition guidelines	Balanced nutrition - Classification of five types of food - Healthy and unhealthy food - Balanced nutrition guidelines
	Wordwall Game	- Balloon pop https://wordwall.net/play/27002/704/998 - Quiz https://wordwall.net/play/26084/763/3690 - Group sort https://wordwall.net/play/26510/617/3450 - Match up https://wordwall.net/play/26544/979/491 - True or false https://wordwall.net/play/26552/580/172	No game sessions
Day 2	PowerPoint slide	Vegetables and fruits - The benefits and impacts of consuming colorful vegetables and fruit - The main content of vitamins and minerals in vegetables and fruit - Dietary Fiber	Vegetables and fruits - The benefits and impacts of consuming colorful vegetables and fruit - The main content of vitamins and minerals in vegetables and fruit - Dietary Fiber
	Wordwall Game	- Quiz https://wordwall.net/play/27269/510/576 - Crossword https://wordwall.net/play/27183/776/226 - Categorize https://wordwall.net/resource/27314621	No game sessions
Day 3	PowerPoint slide	Food exchange lists	Food exchange lists
	Wordwall Game	- Gameshow quiz https://wordwall.net/play/26234/612/399 - Maze chase https://wordwall.net/play/26554/958/346	No game sessions

Results

During the data collection, 110 students were selected from four schools to participate and conduct anthropometric measurements. However,

2 parents did not permit the children to be involved in the study; thus, the total study participants were 108 subjects. The flow of subject's collection is shown in Figure 2.
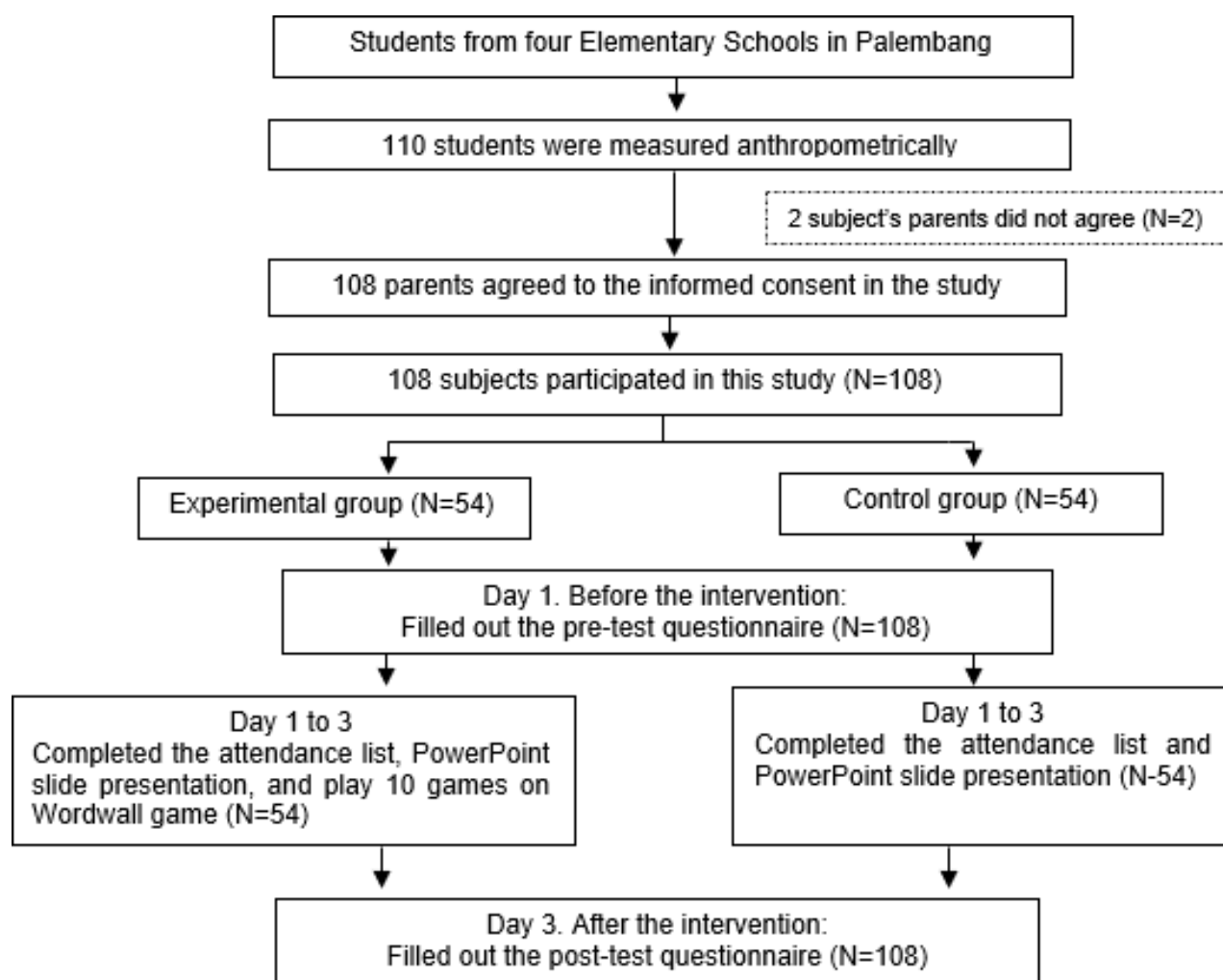
Figure 2. Flow Chart of Subjects

This study allocated subjects into two groups: the experimental group receiving online nutritional education using PowerPoint and Wordwall Game and the control group receiving online nutritional education using PowerPoint media only. All subjects fully participated in this study for 3 consecutive days. Table 2 showed that the majority of subjects were 10 years old, male, and obese. No significant difference was found in the age, gender, and nutritional status of the subjects between the experimental and control group.

Table 2. General Characteristics of Respondents

Parameters	Experimental group (n=54)	Control group (n=54)	Total	p
Children's age*				
10 years old	29(53.7)	19(35.2)	48(44.4)	0.089
11 years old	17(31.5)	28(51.9)	45(41.7)	
12 years old	8(14.8)	7(13.0)	15(13.9)	
Children's sex*				
Male	44(81.5)	35(64.8)	79(73.1)	0.051
Female	10(18.5)	19(35.2)	29(26.9)	
Weight (kg)**	57.83±9.85	57.49±12.11		
Height (cm)**	145.23±8.53	145.72±9.17		
BAZ (kg/m^2)**	2.82±0.68	2.63±0.60		
Nutritional status*				
Overweight	6(11.1)	9(16.7)	15(13.9)	0.404
Obese	48(88.9)	45(83.3)	93(86.1)	

*n(%) and **Mean±SD

Table 3 illustrates that prior to the intervention, all subjects' nutritional knowledge was categorized as poor. After the intervention, there was an increase in nutrition knowledge in both groups. Among those given online nutrition education intervention using PowerPoint and Wordwall Game media (EG), the subjects' nutritional knowledge improved from 100% in the poor category to 72.2% in the fair category and 22.2% in the good category. Meanwhile, in the control group, after participating in online nutrition education using PowerPoint media only, the subjects' nutritional knowledge increased from 100% in the poor category to 74.1% in the fair category, and only 5.5% achieved the good category.

Table 3. Characteristics of Nutrition Knowledge Before and After Education

Level of Nutritional Knowledge	Pre-test		Post-test	
	EG n (%)	CG n (%)	EG n (%)	CG n (%)
Poor	54(100)	54(100)	3(5.6)	11(20.4)
Fair	0(0)	0(0)	39(72.2)	40(74.1)
Good	0(0)	0(0)	12(22.2)	3(5.5)
Total	54(100)	100(100)	54(100)	54(100)
Mean±SD	35.56±7.56	34.59±7.54	74.81±8.64	65.33±9.51
Category	Poor	Poor	Fair	Fair

EG= Experimental group (Using PowerPoint and Wordwall Game); CG= Control group (Using only PowerPoint media)

Table 4 showed the mean score of different domain of knowledge before and after intervention. The mean score of overall nutrition knowledge in the experimental group before online nutrition education was 35.56, and after online nutrition education, the mean score increased to 74.81. The mean score of nutrition knowledge in the control group before online nutrition education was 34.59, and after online nutrition education, it increased to 65.33. The results of the paired t-test indicated a significant difference in the mean score of nutrition knowledge before and after the intervention in both groups, with a p-value of 0.001.

Furthermore, Table 4 also present the differences in nutritional knowledge scores before (pre-test) and after the intervention (post-test) on the six aspects of nutritional knowledge in each group. In the experimental group, following the

intervention using PowerPoint and Wordwall Game, all six aspects of nutritional knowledge (food groups; healthy and unhealthy food choices; nutrition guidelines; vegetables and fruits; dietary fiber; and food exchange lists) significantly increased, with a p-value <0.05. In contrast, in the control group, after the intervention using PowerPoint media only, four aspects of nutritional knowledge exhibited a significant increase with a p-value <0.05, while in the other two aspects (nutrition guidelines and food exchange lists), there was no significant increase,

as indicated by a p-value >0.05. Further exploration revealed that the aspects of nutrition guidelines and food exchange lists did not show an increase in the control group (online nutrition education using only PowerPoint media). The results of the independent t-test analysis are also displayed in Table 4. This statistical test shows that after the intervention in each treatment group, there is a significant difference in the average nutritional knowledge score of the subjects between the experimental group and the control group, with a p-value of 0.001.

Table 4. Changes in Respondents' Knowledge Scores Before and After Intervention in The Experimental and Control Groups

Knowledge Aspect	Experimental	Control	p
Knowledge of food groups**			
Pre-test	66.67 (0 – 100)	66.67 (0-100)	0.771[b]
Post-test	100 (17 – 100)	100 (33-100)	0.044[b]
Δ Score	33.33 (-67 – 83)	33.33 (-17 – 100)	0.634[b]
	p=0.000[a]	p=0.000[a]	
Knowledge of healthy unhealthy food choices**			
Pre-test	20 (20 – 100)	20 (0 – 80)	0.725[b]
Post-test	100 (20 – 100)	80 (0 – 100)	0.002[b]
Δ Score	60 (-40 – 100)	50 (-40 – 100)	0.021[b]
	p=0.000[a]	p=0.000[a]	
Knowledge of nutrition guidelines**			
Pre-test	0 (0 – 100)	0 (0 – 100)	1.000[b]
Post-test	60 (0 – 100)	0 (0 – 100)	0.001[b]
Δ Score	40 (-40 – 100)	0 (-100 – 100)	0.007[b]
	p=0.000[a]	p=0.158[a]	
Knowledge of vegetables and fruits**			
Pre-test	25 (0 – 100)	25 (0 – 100)	0.548[b]
Post-test	100 (50 – 100)	100 (25 – 100)	0.370[b]
Δ Score	75 (-25 – 100)	62.50 (0 – 100)	0.802[b]
	p=0.000[a]	p=0.000[a]	
Knowledge of dietary fiber**			
Pre-test	66.67 (0 – 100)	66.67 (0 – 100)	0.822[b]
Post-test	100 (0 – 100)	100 (0 – 100)	0.266[b]
Δ Score	33.33 (-100 – 100)	0 (-100 – 100)	0.738[b]
	p=0.007[a]	p=0.001[a]	
Knowledge of food exchange lists**			
Pre-test	0 (0 – 100)	0 (0 – 100)	0.923[b]
Post-test	25 (0 – 100)	0 (0 – 100)	0.013[b]
Δ Score	0 (-100 – 100)	0 (-100 – 100)	0.039[b]
	p=0.002[a]	p=0.665[a]	
Overall Nutritional knowledge*			
Pre-test	35.56±7.56	34.59±7.54	
Post-test	74.81±8.64	65.33±9.51	<0.001[d]
	p=<0.001[c]	p=<0.001[c]	
Δ Score	**39.25±10.42**	**30.74±11.90**	**<0.001[d]**

[a]Wilcoxon test, [b]Mann-Whitney test, [c]Paired sample t-test, and [d]Independent t-test

*Mean±SD; **Median (Min-Max)

Table 5 displays the results of the ANCOVA for the nutrition knowledge post-test, to assess the difference in nutritional knowledge after intervention between experimental dan control group, while controlling for pre-test scores of the nutrition knowledge test, gender, and age. The analysis indicated that there was no significant effect of covariates (pre-test score, gender, and age) on the improvement of the post-test scores of nutrition knowledge.

The result of ANCOVA confirm the significant difference in learning achievements between the experimental and the control group (F = 27.03, p < 0.001). The adjusted mean of the experimental group was 74.78, while that of the control group was 65.36, indicating that the nutrition knowledge of the experimental group was significantly higher than that of the control group. This demonstrates that the use of web-based game media (Wordwall Game) during online nutrition education effectively enhances students' nutrition knowledge. An analysis was conducted to further examine the effect of covariates (gender and age group) on increasing nutritional knowledge in the experimental group after being controlled for. The results revealed that there was no significant effect of the covariates (gender and age group) on increasing nutritional knowledge in the experimental group. This suggests that Wordwall Game can be utilized as a media in online learning, suitable and effective for both genders and various age groups.

Table 5. ANCOVA for The Post-Test Results in Nutritional Knowledge with Pre-test Scores, Genders, and Age as a Covariate

Parameter	Group	Mean	S.D.	Std. Error	F	p
Post-test	Experimental	74.81	8.64	1.26	27.03	<0.001
	Control	65.33	9.52	1.26		

*Adjusted mean using ANCOVA after controlling for pre-test, gender, and age

Discussion

The age group of the respondents was in line with the age category of Indonesian children in grade 5 of elementary school. The majority of the students were male. Male children in Indonesia tend to be more overweight and obese.[25]

Supporting this, the Riskesdas report in 2018 revealed that the prevalence of nutritional status based on BMI according to age z-score in children aged 5-12, based on gender, showed a higher proportion of boys with obese nutritional status (10.7%) compared to girls.[3] Furthermore, research by Shah et al[26] demonstrated that girls prefer lower energy and nutrient-dense foods, such as fruits and vegetables, while boys consume more meat and calorie-dense foods. Additionally, girls showed more concern about physical appearance, a desire to lose weight, and guilt associated with over eating. The low level of nutrition knowledge among students found in this study may be related to the lack of nutrition education during the COVID-19 pandemic, in which almost all of the main school health unit (Usaha Kesehatan Sekolah/UKS) services were disrupted. Nonetheless, a previous study among school children also found a low level of nutrition knowledge.[27] However, in this study, after following the online nutrition education conducted for three consecutive days, there was a notable impact on increasing nutritional knowledge, with the subjects' knowledge shifting to the fair and good categories. This indicates that the subjects' knowledge improved, and they grasped the nutrition education material provided. The student learning process is influenced by various factors, including internal factors (such as the physical and psychological state of the subjects), external factors, and the learning methods and media used.[28]

The increase in the mean score of the subjects' nutritional knowledge after the intervention suggests that the learning media used in both groups effectively enhanced the nutritional knowledge of overweight and obese students. Using such learning media can stimulate students' interest in the educational material presented by educators, facilitating better understanding. Engaging and interesting learning media can serve as stimuli for students during the learning process.[18]

The findings of this study suggest that using PowerPoint for delivering material during online learning is more engaging for respondents. PowerPoint effectively presents interesting multimedia content with various images, colors, and designs, while allowing the communicator

to maintain eye contact with the audience.[27] The increase in nutritional knowledge observed in the control group aligns with research reported by Irnani and Sinaga.[28] They also found a difference in the mean nutritional knowledge score, which improved from the poor category to the fair category after providing PowerPoint slide education. Additionally, using Wordwall Game media following the delivery of material through PowerPoint slides demonstrated the ability to increase student learning activities, motivation, and interest in learning. Moreover, Wordwall Game had a positive impact on students' learning outcomes.[29] Siagian et al[30] observed that after using Wordwall-assisted learning media, students' pretest scores significantly improved from an average of 39.79 to 79.37. This demonstrates the influence of Wordwall learning media on the mathematics learning outcomes of elementary school students.

Both internal and external factors influence learning outcomes. Internal factors, including physiological and psychological factors, reside within the student themselves, such as physical health, intelligence, attitude, motivation, and interests. External factors, on the other hand, originate from outside the student and encompass elements such as the learning process, the media employed in learning, the educator's personality, the learning environment, the educator's competence, and the surrounding conditions. The learning process and the media employed represent tangible factors that impact learning outcomes. Overall, learning media plays a pivotal role during the learning process and can significantly enhance the learning experience for students.[31]

Further exploration revealed that the aspects of nutrition guidelines and food exchange lists did not show an increase in the control group (online nutrition education using only PowerPoint media). The pilot test of the nutrition knowledge questionnaire with Australian children indicated that questions related to nutrition guidelines and portion and serving size were challenging for the participants (5th and 6th grade). Despite having the lowest correlation coefficients, nutritionists still recommended these aspects as important knowledge. It is suggested that nutrition education on nutrition guidelines, portion, and serving size should be regularly provided to elementary school children.[11] Another study by Kostanjevec et al[32] analyzed that 11-year-old students acquired general nutrition knowledge, but they faced difficulties in problem-solving regarding complex questions related to balanced nutrition or a healthy diet. The challenges in students understanding nutrition topics are also linked to the level of cognitive development in 11-year-olds. At this age, students can develop logical thinking for solving problems, but they may struggle with abstract and hypothetical problems, including understanding concepts such as balanced nutrition guidelines and classifying food categories based on the content of specific nutrients higher cognition required for these abstract concepts. As a result, using PowerPoint media alone might be challenging in helping students grasp the material, given the limited cognitive development of 11-year-old children. Students also benefit from learning media that allows direct practice to avoid abstract imagination.

The use of game-based learning media is highly suitable for elementary school children, as their mental development is generally at the concrete operational stage, where they perceive everything as real and can be experienced physically. For this reason, the learning media used to create learning conditions must also feel tangible, enabling students to understand the messages conveyed directly.[33] Elementary school students require learning media that incorporates images, sound, and text, which can be controlled based on their preferences. Wordwall Game is a Website-based educational game application that offers various interactive games and quizzes featuring a combination of colors, images, audio, and animation. This blend of multimedia elements is well-suited for elementary school children, promoting happiness and attracting their attention, involvement, and motivation in the learning process.[18]

This indicates that providing online nutrition education using Wordwall Game after presentation sessions using PowerPoint slide media is more effective in enhancing the six aspects of nutritional knowledge in elementary school students than those who only use PowerPoint slides. Incorporating web-based games following the delivery of material through PowerPoint slides contributes to improved student learning outcomes and increases their interest and motivation during online learning.[34] The study by Nadia et al[35] also reported that using the Wordwall application in online mathematics learning led to improved student learning outcomes for 5th-grade students at MI Muhamadiyah 1 Gresik during the COVID-19 pandemic. Another finding in the study by Mettarikanon et al[16] in Thailand revealed that the understanding level of participants in the intervention

group, who utilized Wordwall Game, extended beyond a mere increase in general knowledge related to the material studied. Significantly, it also enhanced participants' capacities for recognition, comparison, distinction, and analysis through repetitive practice. Consequently, the game-based learning approach employing the Wordwall Game creates an immersive practice environment for individuals. Furthermore, participants experience the enjoyment of gameplay in contrast to reading an online pamphlet. Another benefit of employing the Wordwall Game for learning is the augmentation of exceptional visual identification abilities, characterized by accuracy rates exceeding 60%, as reported in several studies.

The advantages of learning through Wordwall Game media include its positive effect on student interest in learning and its effectiveness in enhancing the absorption of learning material. Students feel energized during the learning process because the game aspect stimulates curiosity and provides challenges while completing the tasks.[18] Based on researcher observations during the three days of online nutrition education implementation in the experimental group, students appeared more interested, enthusiastic, and happy during the game session using Wordwall. Some templates in the Wordwall Game created an entertaining atmosphere, and all students were engaged and focused when playing the game. No procrastination was observed, and the learning environment was conducive to active participation.[18]

Wordwall is an online learning media network-based digital gamification application that offers various games with features combining colors, pictures, audio, and animation. Wordwall offers a variety of online and printable games accessible on web-enabled devices like computers, tablets, and smartphones. Wordwall's service can be published on any web server or social media through HTML code and featuring leaderboards. Educators can utilize this application for delivering material evaluation, resulting in students feeling happy and engaged, while attracting their attention, involvement, and motivation in the learning process.[18]

The results of this study align with the findings of Lin et al[34] The ANCOVA indicated that the learning achievement of the experimental group was significantly higher than that of the control group. This demonstrates that using PowerPoint multimedia and computer game-based learning effectively enhances students' nutrition knowledge. The study's outcomes imply that the game-based

learning approach benefits both genders.

The strengths of this study are twofold. First, it stands as the pioneering research within an elementary school-aged population, emphasizing the effectiveness of game-based learning during online education in enhancing nutritional knowledge. Second, the study comprehensively addressed six aspects of nutritional knowledge: food groups, discerning between healthy and unhealthy food choices, nutrition guidelines, understanding vegetables and fruits, dietary fiber, and food exchange lists. As a result, this study boasts a broader coverage of nutritional knowledge compared to earlier research endeavors.[37,38] Nevertheless, certain limitations of the study warrant acknowledgment. Foremost, the school sample included in this study might offer a partial representation of all 18 sub-districts in Palembang. Although the sample selection was executed using a random sampling technique due to the constraints of limited research time, it is advisable that future studies be conducted over extended periods with larger sample sizes to ensure robust findings. The second limitation of this study was encountered on the first day of online nutrition education, where the main issue was the unstable internet network despite each school having Wi-Fi. As a result, some participants still needed to fully receive all the information about balanced nutrition material. This obstacle could impact the study's results. To ensure data quality and minimize bias, the UKS coordinator at the school took the initiative to use projector screens for group viewing, providing a more straightforward presentation to prevent disruptions in case of internet network issues. Additionally, the researchers provided an internet quota to each subject using a smartphone for two consecutive days.

Conclusion

Online nutritional education using Wordwall Game and PowerPoint media effectively improved the nutritional knowledge of overweight and obese elementary school-aged children in Palembang after three days of consecutive intervention. Researchers suggest that future studies incorporate longer observation periods and expand the dependent variables to include other aspects, such as changes in attitudes, dietary fiber consumption, and BMI observations.

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