Submitted: 13 May, 2025 Accepted: 19 August, 2025 Published: 03 January, 2026 DOI:10.22514/jocpd.2026.023

ORIGINAL RESEARCH

Journal of Clinical Pediatric Dentistry

Visual novel game as a new breakthrough in dental health education media for stunted children in Indonesia

Erwin Gunawan[1], Citra Fragrantia Theodorea[2,*], Boy Muchlis Bachtiar[2], Ade Fadly H Masse[3], Gamaliel Juliadi Biring[4], Handika Dwi Prasetyo[5]

[1]Graduate School in Department of Oral Biology, Faculty of Dentistry, Universitas Indonesia, 10430 Jakarta, Indonesia
[2]Department of Oral Biology, Faculty of Dentistry, Universitas Indonesia, 10430 Jakarta, Indonesia
[3]Graduate School in Department of Health Education and Behavioral Sciences, Faculty of Public Health, Universitas Indonesia, 16424 Depok, Indonesia
[4]Graduate School in Department of Industrial Chemical Engineering, Faculty of Engineering, Ujung Pandang State Polytechnic (PNUP), 90245 Makassar, Indonesia
[5]Graduate School in Microbiology Department of Biology, Faculty of Mathematics and Natural Sciences, IPB University, 16680 Bogor, Indonesia

***Correspondence**
citra.fragrantia02@ui.ac.id
(Citra Fragrantia Theodorea)

Abstract

Background: Education level is one of the factors that affect children's oral health status. The research focuses on elementary school-age children due to their limited capacity for formal thought. Educational games are a type of game that not only provides entertainment but also conveys knowledge to their users. Visual novel games offer a new breakthrough to enhance oral health status. The study aimed to evaluate the effectiveness of educational media in the form of a visual novel game as an innovative oral health education tool for stunted children in elementary schools, especially in the Bojongsari area, Indonesia. **Methods**: This study used a quantitative approach with a quasi-experimental one-group pre-test and post-test design to evaluate the effectiveness of visual novel game educational media on improving oral health knowledge in stunted children in Indonesia, which was then reinforced with in-depth interviews as supporting qualitative data. **Results**: The research demonstrated a significant increase in knowledge pre- and post-test, and the majority of students retrieved remarkably satisfying knowledge after playing the game. Statistical analysis revealed a significant difference between pre-test and post-test knowledge scores among stunted children at Sekolah Dasar Negeri (SDN; Public Elementary School) Pontir 2 and Madrasah Ibtidaiyah (MI; Islamic Elementary School) Hidayatul Athfal with a p-value < 0.05. Additionally, the game facilitated information and persuasiveness through adaptation of strong stories, attractive characters, and other characteristics. **Conclusions**: In conclusion, by implementing the strategies, Indonesia is able to increase oral health knowledge, particularly for elementary school-aged stunted children.

Keywords

Children; Education; Game; Oral health; Stunted

1. Introduction

Oral health is an integral part of overall body health, meaning that general health cannot be separated from oral health [1]. The condition of oral health, nutritional status, and general health status are interrelated factors. This is because a person's oral health status can influence their nutritional intake, particularly in children. Poor dietary intake can significantly impact a child's growth and development, potentially leading to stunting [2].

Stunting is a growth and developmental disorder in which children appear shorter than their peers due to insufficient nutritional intake [3]. According to data from the World Health Organization (WHO) in 2024, 23.2% of 12.2 million children globally experienced stunting [4]. With the highest population among all the provinces in Indonesia, West Java has a significant influence on the country. The stunting prevalence in West Java Province in 2021 dropped just by 1.7%, while the prevalence in Indonesia dropped by 3.3%. With Java in 2021 at 24.5%, West Java has the highest stunting prevalence. Additionally, 29.6% of Indonesian children are stunted, with Bojongsari, Depok, West Java, identified as one of the regions with the highest prevalence of stunting [5].

In the literature, stunting can occur in both direct and indirect aspects; one such association exists between oral health status and educational level [4, 6]. A child's level of education can affect their oral health and nutrition because childhood, especially primary school, is a crucial time for growth and development, with the emergence of permanent teeth [7]. It is crucial to make early efforts to protect and promote oral health during this period, as it will significantly impact oral health later in life [8].

Based on the 2023 Indonesian Health Survey (SKI) results, the Decay, Missing, Filling teeth (DMF-T) index shows that, on average, Indonesians have five problematic teeth, placing dental issues among the top ten health concerns treated in primary healthcare services [9]. Among children aged 6–9, an average of one tooth is decayed. West Java ranks 10th

among Indonesia's 38 provinces in terms of dental health issues, including caries. A study in West Java also revealed an average DMF-T index of 4.1, indicating that children typically have four decayed teeth [10].

The target area of this research is Sekolah Dasar Negeri (SDN; Public Elementary School) Pontir 2 and Madrasah Ibtidaiyah (MI; Islamic Elementary School) Hidayatul Athfal Curug Bojongsari, Depok, West Java. Situation analysis and data obtained from Bojongsari Health Center, indicates that 14 students at SDN Pontir 2 and 7 at MI Hidayatul Athfal Curug have experienced stunting. Analysis reveals that the health issues of dental caries and stunting are related to behavioral, environmental, and familial support factors. Elementary school-aged children generally have not yet developed formal thinking skills, as their logic is still in the concrete operational stage [11]. Thus, health promotion media are needed to help students understand and improve their oral and nutritional health standards [12]. Oral health education techniques and methods can be implemented in schools through diverse teaching methods, such as lectures, printed media, or digital technology [13].

In today's digital era, children tend to have significant engagement with digital technology, a trend predicted to increase substantially in the coming years. It is undeniable that children in this digital age are highly drawn to gadgets [14]. This attraction is influenced by their high adaptability to technology. According to previous research, educational games offer benefits in four aspects: context creation, interactivity, instant feedback, and emotional experience [15]. Educational games are a type of game that not only provides entertainment but also conveys knowledge to it's users. Educational games can serve as a medium for learning through play, representing an educational breakthrough; one example is visual novel games [16, 17].

Visual novel games are innovative and interactive creations that serve as a new approach to providing Android-based education aimed at improving oral health. The purpose of this study is to evaluate the effectiveness of educational media, specifically visual novel games, as an innovative tool for teaching oral health to stunted children in elementary schools, particularly in the Bojongsari area of Indonesia. Accordingly, the null hypothesis of this study is that the use of visual novel games as educational media has no significant effect on improving oral health among stunted elementary school children. In contrast, the alternative hypothesis is that the use of visual novel games as educational media has a significant effect on improving oral health among stunted elementary school children.

2. Material and methods

This study used a quantitative approach with a quasi-experimental one-group pre-test and post-test design to evaluate the effectiveness of visual novel game educational media on improving oral health knowledge in stunted children in Indonesia, which was then reinforced with in-depth interviews as supporting qualitative data. Researchers recruited 101 children aged 6–8 years who were classified as stunted according to the WHO criteria (height-for-age z-score < -2 Standard Deviation (SD)), selected based on the high prevalence of stunting and caries.

The recruitment of study participants involved several essential steps. First, clear information was provided about the purpose of the research, which was to determine children's knowledge of oral health care and their level of satisfaction after playing a visual novel game. Participants were required to complete a pre-test questionnaire, watch and simulate playing the visual novel game, participate in a quiz and question-and-answer session, and complete a post-test questionnaire and a satisfaction survey.

Additionally, the recruitment process included reading or explaining the information sheet and assent form to the child and their parent/guardian, providing an opportunity to ask questions, and ensuring that all questions were answered adequately. Consent was given freely and voluntarily, without any coercion, with full awareness that participation could be refused or withdrawn at any time without any cost or other consequences.

The study was guided by purposive sampling and cross-sectional research design, and was conducted in Madrasah Ibtidaiyah (MI; Islamic Elementary School) Hidayatul Athfal Curug, Bojongsari Subdistrict, Depok, West Java on 11 October 2024 and Sekolah Dasar Negeri (SDN; Public Elementary School) Pontir 02 Bojongsari Subdistrict, Depok, West Java on 14 October 2024. Furthermore, questionnaires were created. The questionnaires of SDN Pontir 02 Bojongsari and MI Hidayatul Athfal Bojongsari have been added in the **Supplementary material**.

The quantitative instrument was a knowledge questionnaire on dental health using a 4-point Likert scale that was developed by the researcher and had undergone validity and reliability tests before use. The same questionnaire was used in the two intervention schools, namely SDN Pontir 2 and MI Hidayatul Athfal, to allow comparison of knowledge levels between the locations. A pre-test was conducted before the intervention, and a post-test was conducted seven days after the intervention, where children played the educational Visual Novel Game for 20–30 minutes per day for one week.

Data were analyzed using a paired sample t-test to determine the difference in knowledge before and after the intervention and a chi-square test was used to assess the relationship between nutritional status and knowledge level. Knowledge was measured using a questionnaire, whose scores were categorized into two groups, namely good and poor, based on predetermined assessment scores. Satisfaction with educational media was measured using a 1–10 Likert scale, with a score of 1 indicating very low satisfaction and a score of 10 indicating very high satisfaction. In-depth interviews were conducted as a deepening of qualitative data with five teachers using a semi-structured approach to explore their perceptions, experiences, and understanding of the educational media provided.

The visual development in the game was designed attractively and adapted to the age characteristics of the children, as shown in Fig. 1. This educational game can be accessed online through the following link: https://bit.ly/myprofile-online. The study obtained ethical approval from the Dian Nuswantoro University Research Ethics Committee with Number 002795/UNIVERSITAS

FIGURE 1. Development design of visual novel game.

DIAN NUSWANTORO/2024, and informed consent was obtained from parents or guardians of participating children.

3. Results

3.1 Quantitative data

3.1.1 Univariate

Based on Table 1, the results of the validity test of 10 question items in the research instrument, indicate that 3 items were declared invalid. The validity test was performed using the Pearson Product-Moment Correlation (Corrected Item-Total Correlation) method to examine each item's correlation with the total score. The results show that most questionnaire items have an item-total correlation coefficient greater than 0.3, indicating that they are valid. Out of the 10 questions, 7 items met the validity criteria with a correlation coefficient $\geq$0.3. Meanwhile, 3 items had a coefficient below 0.3, namely the questions about toothbrush replacement frequency, brushing duration, and the recommended time for dental check-ups. The evidence shows that the three items are not able to measure exactly the aspects referred to in the oral health knowledge indicator.

Furthermore, reliability testing was carried out using Cronbach's Alpha to determine the internal consistency of the instrument. According to the reliability test results, all items had a value that exceeds the minimum limit of 0.60, which means that they were all declared reliable. This high reliability value indicates that the instrument used is quite consistent in measuring children's knowledge. Thus, although there are some items that need to be revised because they are invalid, in general this instrument has excellent feasibility and reliability and can be used in this study.

Table 2 shows the characteristics of 101 respondents from the two schools, consisting of 51 students from SDN Pontir 2 Bojongsari and 50 students from MI Hidayatul Athfal Curug. Participants were selected using purposive sampling based on the criteria of being stunted children aged 6–8 years. The data analyzed include categorical data (gender, class, nutritional status, pre-test and post-test knowledge categories, and application satisfaction) and continuous data (age, pre-test and post-test knowledge scores), which are examined using descriptive statistics, paired *t*-tests for children's knowledge levels, and chi-square analysis for the relationship between students' knowledge levels and stunting incidence.

SDN Pontir 2 Bojongsari was dominated by female students (56.9%) and 7-year-olds (80.4%). Most students were in Class 1A (56.9%). The pre-test results showed that the majority of students (84.3%) fell into the poor knowledge category, while the post-test showed a significant improvement, with 33.3% of students in the good category. In terms of nutritional status, most students (72.5%) had normal nutritional status, while 27.5% experienced stunting. The satisfaction level with the visual novel game used was high, with 86.3% of students reporting satisfaction.

Analysis of the frequency distribution data for respondent characteristics at MI Hidayatul Athfal Curug provides a clear profile of the students. Of the 50 respondents, the majority were female (64%) and 7 years old (54%). Most students were in Class 1A (54%). The pre-test results indicated that the majority of students (68%) fell into the poor knowledge category. However, after the dental health education intervention, there was a significant improvement in post-test results, with 78% of students in the good category. This indicates

TABLE 1. Assessment of the validity and reliability in research questionnaire.

No	List of Questions	Validity	Reliability
1	Foods that should keep teeth from getting cavities are?	0.457[a]*	0.755[b]*
2	When brushing your teeth, how much toothpaste do you use?	0.437[a]*	0.663[b]*
3	Should I brush my teeth on time?	0.552[a]*	0.693[b]*
4	Toothbrushes should be replaced every?	0.183	0.756[b]*
5	How long should we brush our teeth?	0.102	0.730[b]*
6	We need to check up to the dentist every?	0.147	0.761[b]*
7	Our teeth and mouth are for?	0.474[a]*	0.684[b]*
8	The correct way to brush your teeth is?	0.719[a]*	0.743[b]*
9	If the teeth are not cleaned properly, there will be?	0.327[a]*	0.792[b]*
10	After eating candy or chocolate, you should?	0.503[a]*	0.702[b]*

Source: Primary Data, 2024.

[a] **Correlation Coefficient ≥0.3 indicates statistically significant correlation in the validity test (items considered valid);* [b] **Cronbach's Alpha ≥0.60 indicates the item is reliable.*

TABLE 2. Frequency distribution of respondent characteristics.

Characteristics	SDN Pontir 2 Bojongsari		MI Hidayatul Athfal Curug		Total	
	Frequency (N)	Percentage (%)	Frequency (N)	Percentage (%)	Frequency (N)	Percentage (%)
Gender						
Male	22	43.1	18	36.0	40	39.6
Female	29	56.9	32	64.0	61	60.4
Age						
6 Years	8	15.7	21	42.0	29	28.7
7 Years	41	80.4	27	54.0	68	67.3
8 Years	2	3.9	2	4.0	4	4.0
Mean ± SD (yr)		7.1 ± 0.5		6.6 ± 0.6		6.85 ± 0.55
Class						
1A	29	56.9	27	54.0	56	55.4
1B	22	43.1	23	46.0	45	44.6
Pre-Test Knowledge Category						
Good	8	15.7	16	32.0	24	23.8
Poor	43	84.3	34	68.0	77	76.2
Mean ± SD Pre-Test Knowledge Score		3.61 ± 1.51		4.90 ± 1.34		4.25 ± 1.47
Post-Test Knowledge Category						
Good	17	33.3	39	78.0	56	55.4
Poor	34	66.7	11	22.0	45	44.6
Mean ± SD Post-Test Knowledge Score		4.96 ± 2.08		6.14 ± 1.59		5.54 ± 1.90
Nutritional Status						
Normal	37	72.5	43	86.0	80	79.2
Stunting	14	27.5	7	14.0	21	20.8
Application Satisfaction Category						
Satisfied	44	86.3	44	88.0	88	87.1
No Satisfied	7	13.7	6	12.0	13	12.9
Total Respondents	51	100.0	50	100.0	101	100.0

Source: Primary Data, 2024.

SDN: Sekolah Dasar Negeri (SDN) (Public Elementary School); MI: Madrasah Ibtidaiyah (MI) (Islamic Elementary School); SD: Standard Deviation.

the effectiveness of the educational program or intervention provided. In terms of nutritional status, the majority of students (86%) had normal nutritional status, while 14% experienced stunting. The satisfaction level with the visual novel game used was also high, with 88% of students reporting satisfaction.

3.1.2 Bivariate

Table 3 shows the comparison results between students' knowledge levels before and after oral health education using the visual novel game at SDN Pontir 2 Bojongsari. The *t*-test results showed a statistically significant difference ($p < 0.05$) between the pre-test and post-test average scores, indicating that the health education program effectively improved students' knowledge levels especially for stunted children.

For MI Hidayatul Athfal Curug, there was a statistically significant difference ($p < 0.05$) between the average knowledge scores of students before and after the oral health education intervention, particularly among stunted children at MI Hidayatul Athfal Curug. These findings indicate that the educational program implemented successfully improved students' understanding of the importance of oral health.

The oral health education intervention proved to be effective in increasing students' knowledge of oral health. This increase in knowledge is an important first step in efforts to improve oral health behavior in students.

Table 4 shows Chi-square analysis of the relationship between students' knowledge levels and stunting incidence at SDN Pontir 2 Bojongsari. Statistical analysis results show no statistically significant difference ($p > 0.05$) in the proportion of stunted students among groups with good and poor knowledge.

At MI Hidayatul Athfal Curug, there was no statistically significant relationship between student knowledge and stunting ($p > 0.05$). This means that there was no significant difference between the proportion of students experiencing stunting in the high- and low-knowledge groups.

Table 5 presents a comparison of students' knowledge levels especially for children with stunted growth after health education intervention or post-test at two different schools, SDN Pontir 2 Bojongsari and MI Hidayatul Athfal Curug. Statistical analysis indicated a significant difference ($p < 0.05$) between the average knowledge scores of students at both schools.

Students at MI Hidayatul Athfal Curug achieved significantly higher knowledge scores than those at SDN Pontir 2 Bojongsari, indicating that the health education program at MI Hidayatul Athfal Curug was more effective in increasing students' knowledge. This significant difference indicates that the health education programs implemented in the two schools have different effectiveness.

3.2 Qualitative data

3.2.1 Characteristics of informants

Table 6 lists data for five female respondents with initials W1 to W5. All respondents were female and had a Bachelor's Degree educational background. They all worked as teachers, with the same position within the educational environment, providing a consistent profile of the respondents as female teachers with a bachelor's qualification.

3.2.2 Satisfaction

Interviews revealed various opinions about the educational application aimed at teaching stunted children the importance of brushing teeth. Several informants highlighted the importance of explaining the reason behind activities like brushing teeth so that children can understand the value of these activities. They also emphasized the importance of not rushing through the information so that children can follow instructions, especially if there is text to be read. Small font size was also a concern, and some suggested increasing the font size for easier reading by children.

"*It's interesting... the main issue is explaining why we need to brush teeth, and not rushing through it... kids might not be able to read, so they ask, 'Mom, what does this say?' And the font size should be bigger—it's too small.*" (W1)

"*It's interesting, but a bit fast-paced... but still interesting.*" (W2)

"*The education is good, as it uses images to convey information, so it's better than just using PowerPoint.*" (W5)

Regarding the character design, some informants felt that the mother character did not look like a typical mother, especially in the local cultural context where mothers usually wear a headscarf. They noted that children might not recognize this character as a mother figure. However, the storyline was seen as interesting and effective in encouraging children to brush their teeth more diligently. Other informants felt that

TABLE 3. The impact of health education on children's knowledge levels before and after education.

Knowledge	Category	N	Mean	SD	Mean Difference	*t*	*p*-value	95% CI
SDN Pontir 2 Bojongsari								
	Pre-Test	51	3.61	1.511	−1.353	−4.935	<0.001	−1.90 to −0.80
	Post-Test	51	4.96	2.078				
MI Hidayatul Athfal Curug								
	Pre-Test	50	4.90	1.344	−1.240	−5.241	<0.001	−1.71 to −0.76
	Post-Test	50	6.14	1.591				

Source: Primary Data, 2024.
SDN: Sekolah Dasar Negeri (SDN) (Public Elementary School); MI: Madrasah Ibtidaiyah (MI) (Islamic Elementary School); SD: Standard Deviation; CI: Confidence Interval.

TABLE 4. The impact of children's knowledge levels on stunting incidence.

Knowledge	Nutritional Status						*p*-value
	Normal		Stunting		Total		
	n	%	n	%	N	%	
SDN Pontir 2 Bojongsari							
Good	12	70.6	5	29.4	17	100	
Poor	25	73.5	9	26.6	34	100	0.824
Total	37	72.5	14	25.7	51	100	
MI Hidayatul Athfal Curug							
Good	34	87.2	5	12.8	39	100	
Poor	9	81.8	2	18.2	11	100	0.651
Total	43	86.0	7	14.0	50	100	

Source: Primary Data, 2024.
SDN: Sekolah Dasar Negeri (SDN) (Public Elementary School); MI: Madrasah Ibtidaiyah (MI) (Islamic Elementary School).

TABLE 5. Comparison of knowledge levels after education at SDN Pontir 2 and MI Hidayatul Athfal Curug.

Schools	N	Mean	SD	Mean Difference	*t*	*p*-value	95% CI
SDN Pontir 2 Bojongsari	51	5.04	2.020	5.040	17.644	<0.001	4.47–5.61
MI Hidayatul Athfal Curug	50	6.14	1.591	6.140	27.290	<0.001	5.69–6.59

Source: Primary Data, 2024.
SDN: Sekolah Dasar Negeri (SDN) (Public Elementary School); MI: Madrasah Ibtidaiyah (MI) (Islamic Elementary School); SD: Standard Deviation; CI: Confidence Interval.

TABLE 6. Characteristics of informants by initials, gender, education, and position.

NO	Initials	Gender	Education	Position
1	W1	Female	Bachelor's Degree	Teacher
2	W2	Female	Bachelor's Degree	Teacher
3	W3	Female	Bachelor's Degree	Teacher
4	W4	Female	Bachelor's Degree	Teacher
5	W5	Female	Bachelor's Degree	Teacher

Source: Primary Data, 2024.

the characters were suitable and appealing for children.

"*As for the character, the mother doesn't quite fit. The children here would say, 'That's not Mom, but her sister.' A mother would usually wear a headscarf.*" (W1)

"*The characters are clear and suitable for children; it's well-designed for them.*" (W4)

"*It's fine for a general audience, but at an Islamic school, the characters should ideally be covered with a headscarf.*" (W2)

"*The characters are good; they serve as a reminder.*" (W3)

Some respondents also commented that the storyline was too quick, making the game feel short, while others appreciated that it was not boring and offered choices for answering questions. The overall visual design was seen as appealing to children, though adding sound was suggested to make the experience more engaging.

"*The storyline ends quickly, so it feels like, 'Is that all?' It's too short; they'd want to keep playing.*" (W1)

"*I think it's fine, and not too long either, so it doesn't get boring.*" (W2)

"*It's not boring, but it could use some added sound effects.*" (W4)

"*It's not boring because the game progresses, unlike static images. It's nice that there are options to choose from, not just images.*" (W5)

The ease of playing the game was also noted. Informants mentioned that today's children are generally more skilled at playing games than previous generations, making the game accessible to them. However, small text size was criticized, especially on mobile devices. The game was easy for children who could read, though audio would enhance accessibility for all.

"*It's quite easy to play, since most kids these days are better at games than we are, haha.*" (W1)

"*It's easy, especially since it's a game, and young children, particularly first graders, enjoy it.*" (W4)

"*The text is small and fast-paced; perhaps it appears small because it's on a phone.*" (W2)

"*The game is easy for children who can read, but since*

there's no audio, it would be better with added sound to reach more children." (W3)

Furthermore, the informants stressed that children prefer playing games over other educational media, like posters. They felt that the game better aligns with children's real lives, where they tend to enjoy sweets and may resist brushing their teeth. The game's information was considered engaging and effective, especially compared to other, more static media like PowerPoint.

"*They enjoy playing games more than other media like posters. Playing games together to brush their teeth is more realistic—they would definitely enjoy it more than other methods.*" (W1)

"*It's more engaging than other media; most media today is like this, too.*" (W2)

"*This is new and therefore more engaging than other educational media they haven't seen before.*" (W4)

"*It's relevant because kids are often hard to persuade to brush their teeth.*" (W3)

"*Yes, it's well-suited to their real life—they already like sweets and are reluctant to brush their teeth, which leads to dental problems.*" (W1)

"*It's more engaging than other media, especially compared to the usual PowerPoint presentations.*" (W5)

"*This aligns well with their real-life experiences, like when they're told to brush their teeth but don't want to.*" (W5)

4. Discussion

This study aimed to assess the effectiveness of a visual novel game as a medium for improving oral health knowledge among stunted children aged 6–8 years in two elementary schools in Bojongsari, Depok. The results revealed a notable increase in knowledge after the intervention, particularly in key areas such as the correct timing for brushing teeth and when to replace a toothbrush. This suggests that visual, narrative-based educational media can enhance knowledge retention among children in the concrete operational stage of development, who are still forming logical reasoning and benefit from interactive, concrete learning experiences.

The use of game-based media aligns with existing literature emphasizing the effectiveness of digital interventions in promoting oral health education. Prior studies have shown that interactive games increase engagement, stimulate memory, and support emotional and cognitive development in young learners. The findings of this study are consistent with the work of Moreira *et al*. [18] who reported that smartphone-based educational games significantly improved children's knowledge about oral health. Similarly, classroom observations and teacher interviews in this study confirmed that students responded enthusiastically to the visual novel game, discussing the content with peers and showing greater interest in the material compared to traditional methods. These results underscore the importance of engaging, age-appropriate health promotion strategies for vulnerable groups such as stunted children.

In general, pre-test results indicate that respondents' knowledge from both schools, Sekolah Dasar Negeri (SDN; Public Elementary School) Pontir 2 and Madrasah Ibtidaiyah (MI; Islamic Elementary School) Hidayatul Athfal Curug in Bojongsari, Depok, regarding oral health, remains relatively low especially for children with stunted growth. This is supported by the findings that two specific pre-test items namely, the appropriate time for brushing teeth and when to replace a toothbrush scored very low [11]. This may be influenced by the fact that most respondents were aged 6–8 years, an age where they are still in the concrete operational stage of cognitive development and have yet to fully develop logical thinking [12]. This outcome suggests a need for an effective health promotion medium to help children absorb new information.

Health promotion media targeting elementary school children is a crucial strategy to enhance and maintain oral health. Research indicates that educational interventions utilizing audiovisual game-based media are effective in stimulating learning among school-aged children [19]. Engaging game-based interventions, such as crossword puzzles, augmented reality, and other interactive media, have been suggested as beneficial learning tools for promoting dental health. Using games for dental health education can serve as an alternative to teaching fundamental health concepts, supporting cognitive development, and building children's confidence [20].

The findings from this study align with previous research showing that educational media games increase participants' knowledge and engagement [21]. For instance, Moreira *et al*. [18] found that using a gamified smartphone application positively affected the knowledge levels of young children involved in the study. This evidence suggests that game-based education can effectively attract children's interest, delivering information in a more enjoyable and engaging format [22]. Other research supports that games used as educational media can enhance various cognitive aspects, such as memory, attention, multitasking, and learning effectiveness, and can benefit motor, social, motivational, and emotional development [23].

Moreover, studies highlight positive behavioral changes and satisfaction with using games in educational settings. The use of games as a teaching method creates an enjoyable atmosphere, which attracts children's interest and increases their satisfaction with the educational approach [24]. Game-based health education, particularly when delivered on mobile devices, can act as a reminder to educate and entertain children, motivating them to maintain good oral health practices and leading to positive behavioral changes. Additionally, these behavioral changes are often attributed to an increase in knowledge following game-based education [25].

This study's findings also align with research by Wardani *et al*. [26] demonstrating that dental and oral health education positively impacts knowledge levels among elementary students at SDN 02 Tiron Madiun. Other research by Gurav *et al*. [27] revealed significant differences in dental and oral health status among school children aged 5–16 following health education. A study by Saidah *et al*. [28] similarly found a meaningful difference in children's oral health knowledge before and after educational interventions on proper brushing techniques among children in Rejowinangun.

Contrastingly, findings from this research differ from other literature that shows only marginal improvement in oral health after similar interventions. This discrepancy may be due to factors like a limited sample size and shorter observation periods. Providing health education that integrates engag-

ing, game-based learning can boost children's knowledge and promote positive behavior change. For instance, research by Aljafari *et al*. [29] demonstrated that game-based education enhanced children's knowledge and contributed to healthier dietary habits, thereby reducing caries risk and improving their oral health status.

Qualitative interviews with teachers from both schools supported the effectiveness of using visual novel games for learning. The teachers observed that students were enthusiastic and eagerly engaging with the educational game. This finding echoes the study's principle observation that game-based learning aligned well with the existing curriculum and served as an effective teaching medium. Beyond the health material itself, students enjoyed socializing and discussing the game content with their peers, creating an interactive and enjoyable learning experience [30].

Oral health education aims to provide knowledge that closely relates to daily actions in maintaining dental and oral health. The selection of health education materials is prioritized to foster behaviors like regular brushing and mindful consumption of certain foods, such as sweets. Selecting appropriate educational materials and prioritizing the target audience is essential, considering the impact and urgency of addressing dental health issues [31].

4.1 Strengths of the study

This study possesses several strengths that support the validity and contextual relevance of its findings. First, the use of an educational medium in the form of a visual novel game is an innovative approach that aligns with the digital trends among elementary school children. This innovation leverages children's interest in technology and interactive games to deliver oral health messages in an engaging and easily understandable way. Moreover, the research design applies combining a quantitative quasi-experimental pre-test and post-test design with qualitative data gathered through in-depth interviews with teachers.

This combination enriches the study's perspective by providing objective statistical results alongside contextual insights from relevant informants. The research instrument, a knowledge questionnaire, was tested for validity and reliability, ensuring that it accurately and consistently measures children's knowledge. Conducting the study in Bojongsari, an area with a high prevalence of stunting, further strengthens the contextual relevance of the findings for local intervention programs. From an ethical standpoint, the study obtained formal ethical approval and informed consent from parents or guardians, demonstrating adherence to responsible research principles.

4.2 Study limitations

This study has several limitations that need to be considered. Methodologically, the study participants were children aged 6–8 years who were still in the concrete operational stage of cognitive development, according to Piaget's theory. At this stage, children's ability to understand more complex logical concepts related to oral health is still limited.

Then there are methodological limitations related to ethical aspects, where the code of ethics for research on children over 5 years old has not been specifically regulated or officially issued, so the implementation of this study was carried out while still referring to the general principles of research ethics but without specific ethical guidelines for this age group. This is important because the definition of stunting used in Indonesia officially includes children under 5 years of age, while this study involved primary school-aged children who are above this age limit. Discrepancies between the target age group and the national standard definition of stunting may affect the interpretation and generalizability of the findings.

The relatively small sample size, limited to two schools in a single area, also restricts the generalizability of the findings to a wider population. In terms of duration, the intervention period was relatively short, only seven days. without any long-term follow-up, so the long-term impact on children's behavior and oral health status could not be assessed. Technically, based on feedback from teachers, there are several aspects of the educational media that still need improvement, such as the small font size, the absence of audio or narration, and character designs that are not fully aligned with the local cultural context. These factors could affect the comfort and effectiveness of the game as a learning medium.

5. Conclusions

This study highlights the effectiveness of game-based education, specifically through a visual novel game, as an innovative approach to improving dental health knowledge among stunted children in Indonesia. Statistical analysis shows that there is a significant difference between pre-test and post-test knowledge scores in stunted children at Sekolah Dasar Negeri (SDN; Public Elementary School) Pontir 2 and Madrasah Ibtidaiyah (MI; Islamic Elementary School) Hidayatul Athfal Curug with a p-value < 0.05. It shows that interactive and engaging educational media can successfully raise awareness and understanding of important oral health practices. The findings underscore that visual novel games not only enhance cognitive comprehension but also foster positive behavioral changes and satisfaction among users.

In conclusion, the integration of digital game-based media into health education could serve as an important investment in preventive healthcare for young populations. By increasing access to health knowledge and encouraging positive habits, educational games offer a scalable, adaptable solution to promote long-term health improvements. Future studies could expand on these findings by examining the impact of sustained game-based interventions and exploring similar strategies for other health education areas.

AVAILABILITY OF DATA AND MATERIALS

The datasets used and/or analyzed during the current study are available from the corresponding authors upon reasonable request.

AUTHOR CONTRIBUTIONS

EG and HDP—conceptualized the manuscript; carried out data analysis; drafted the manuscript. AFHM and GJB—carried out the methodology; edited the manuscript. CFT and BMB—supervised the project, provided critical revisions of intellectual content, and oversaw project administration. All authors subsequently revised the drafts. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Ethical approval for this study is granted by the Research Ethics Committee of Universitas Dian Nuswantoro, Indonesia (Code of ethics: 002795/UNIVERSITAS DIAN NUSWANTORO/2024). The clearance is predicated on seven WHO 2011 Standard and Guidance part III, namely the Ethical Basis for Decision-making, with regard to the adherence to the 2016 CIOMS Guideline. Informed consent was obtained from all parents/caregivers of participants included in the study.

ACKNOWLEDGMENT

The authors would like to thank all participants who willingly took part in this research. The authors also acknowledge that the article processing charge is funded by the Faculty of Dentistry, Universitas Indonesia, awarded to CFT.

FUNDING

This research is supported by the PUTI Pascasarjana Program of Universitas Indonesia (Grant no. NKB-90/UN2.RST/HKP.05.00/2024) to CFT.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

SUPPLEMENTARY MATERIAL

Supplementary material associated with this article can be found, in the online version, at https://oss.jocpd.com/files/article/2006280892987654144/attachment/Supplementary%20material.docx.

REFERENCES

[1] Salsabila N, Kasuma N, Yerizel E. Determination of the number of Porphyromonas Gingivalis ATCC 33277 in Salivaof Stunted Children. e-GiGi. 2023; 12: 26–31. (In Indonesian)

[2] Nelwan SC, Tedjosasongko U, Dewi AM, Ayuningtyas P. Parathyroid hormone-related protein and primary teeth eruption in stunting children. World Journal of Advanced Research and Reviews. 2022; 14: 016–021.

[3] Akbar RR, Kartika W, Khairunnisa M. The effect of stunting on child growth and development. Scientific Journal. 2023; 2: 153–160.

[4] United Nations Children's Fund (UNICEF), World Health Organization & World Bank. The UNICEF-WHO-World Bank joint child malnutrition estimates (JME) standard methodology: tracking progress on SDG indicators 2.2.1 on stunting, 2.2.2 (1) on overweight and 2.2.2 (2) on wasting. 2024. Available at: https://www.who.int/publications/i/item/9789240100190 (Accessed: 10 August 2025).

[5] Devi YP, Herdayati M, Makful MR, Muthmainnah M, Ekoriano M, Ruwandasari N, *et al*. Spatial analysis of stunting prevalence according to family data collection indicators in Indonesia. Media Publikasi Promosi Kesehatan Indonesia. 2025; 8: 210–220.

[6] Gunawan E, Puspitawati R. Relationship between Vitamin D deficiency and lipopolysaccharides *Porphyromonas gingivalis* bacteria in stunting children. Annals of Biomedical Science and Engineering. 2024; 8: 59–65.

[7] Minervini G, Franco R, Marrapodi MM, Fiorillo L, Cervino G, Cicciù M. The association between parent education level, oral health, and oral-related sleep disturbance. An observational crosssectional study. European Journal of Paediatric Dentistry. 2023; 24: 218–223.

[8] Sinchez CJA, Villar BS, Fraiz FC, Lopez RVM, Bavaresco CS, Haddad AE. Association between early admission at school and oral health and nutritional status of children in the city of São Paulo, Brazil. Brazilian Research in Pediatric Dentistry and Integrated Clinic. 2021; 21: 1–10.

[9] Health Development Policy Agency, Ministry of Health of the Republic of Indonesia. SKI 2023 in numbers. 2023. Available at: https://www.badankebijakan.kemkes.go.id/en/ski-2023-dalam-angka/ (Accessed 10 August 2025).

[10] Dewi PK, Aripin D, Suwargiani AA. DMF-T and def-t index among children in Mekarjaya public elementary school, Cimenyan subdistrict, Bandung, Indonesia. Padjadjaran Journal of Dental Researchers and Students. 2017; 1: 123.

[11] Cerovac M, Keane T. Early insights into Piaget's cognitive development model through the lens of the Technologies curriculum. International Journal of Technology and Design Education. 2024; 35: 61–81.

[12] Djannah SN, Trisnowati H, Tukiyo IW, Solikhah S. Dental and oral health education media: effectiveness in improving health students' knowledge and attitudes. Disease Prevention and Public Health Journal. 2025; 19: 11–19.

[13] Bakhtiar M, Hosseini SM, Behbahanirad A, Kamyab A, Khani Jeihooni A. Preparation and evaluation of a multimedia oral health education software for teenagers. BMC Oral Health. 2025; 25: 712.

[14] Johnston K. Engagement and immersion in digital play: supporting young children's digital wellbeing. International Journal of Enviromental Research and Public Health. 2021; 18: 10179.

[15] Kaźmierczak R, Skowroński R, Kowalczyk C, Grunwald G. Creating interactive scenes in 3D educational games: using narrative and technology to explore history and culture. Applied Sciences. 2024; 14: 4795.

[16] Li Z. An analysis of the effect of educational games on cultivating students' interest in subjects. Lecture Notes in Education Psychology and Public Media. 2024; 42: 27–31.

[17] Khoiruddin MH, Bahari ZHZ, Kaka MS, Saenpich S. Development of visual novel games as learning media for the history of Indonesia's independence. Journal of Educational Technology and Learning Creativity. 2023; 1: 33–41.

[18] Moreira R, Silveira A, Sequeira T, Durão N, Lourenço J, Cascais I, *et al*. Gamification and oral health in children and adolescents: scoping review. Interactive Journal of Medical Research. 2024; 13: e35132.

[19] Almalki SA, Adil AH, Mustafa M, Karobari MI. Assessing oral health knowledge among public school children in Saudi Arabian subpopulation. Journal of Health, Population and Nutrition. 2024; 43: 126.

[20] Ram Surath Kumar K, Deshpande AP, Ankola AV, Sankeshwari RM, Jalihal S, Hampiholi V, *et al*. Effectiveness of a visual interactive game on oral hygiene knowledge, practices, and clinical parameters among adolescents: a randomized controlled trial. Children. 2022; 9: 1828.

[21] Ezzat R. Gamification to increase engagement and impact on students through education process. International Design Journal. 2024; 14: 375–386.

[22] Li Y, Chen D, Deng X. The impact of digital educational games on student's motivation for learning: the mediating effect of learning engagement and the moderating effect of the digital environment. PLOS ONE. 2024; 19: e0294350.

[23] Parthasarathy PK, Mittal A, Aggarwal A. Literature review: learning through game-based technology enhances cognitive skills. International Journal of Professional Business Review. 2023; 8: 1–33.

[24] Zaror C, Mariño R, Atala-Acevedo C. Current state of serious games in dentistry: a scoping review. Games for Health Journal. 2021; 10: 95–108.
[25] Rasmus K, Toratti A, Karki S, Pesonen P, Laitala ML, Anttonen V. Acceptability of a mobile application in children's oral health promotion—a pilot study. International Journal of Environmental Research and Public Health. 2021; 18: 1–9.
[26] Wardani NEP, Putri AW, Ramadhanintyas KN. Dental and oral health counseling efforts on students' knowledge levels (SDN 02 Tiron Madiun). International Journal of Health Literacy and Science. 2023; 1: 35–40.
[27] Gurav KM, Shetty V, Vinay V, Bhor K, Jain C, Divekar P. Effectiveness of oral health educational methods among school children aged 5–16 years in improving their oral health status: a meta-analysis. International Journal of Clinical Pediatric Dentistry. 2022; 15: 338–349.
[28] Saidah A, Isni K. The effect of dental and oral health education on children's knowledge level in Rejowinangun village, Yogyakarta. Media Publikasi Promosi Kesehatan Indonesia. 2022; 5: 205–210. (In Indonesian)
[29] Aljafari A, Elkarmi R, Nasser O, Atef A, Hosey MT. A video-game-based oral health intervention in primary schools—a randomised controlled trial. Dentistry Journal. 2022; 10: 1–11.
[30] Aprilia K, Yudiernawati A, Rachman MZ. Board game-based education to improve knowledge and skills in dental caries prevention among school-aged children. Journal of Health Research Science. 2024; 4: 328–335. (In Indonesian)
[31] Cascaes AM, Da Silva NRJ, Fernandez MDS, Bomfim RA, Vaz JDS. Ultra-processed food consumption and dental caries in children and adolescents: a systematic review and meta-analysis. British Journal of Nutrition. 2023; 129: 1370–1379.

How to cite this article: Erwin Gunawan, Citra Fragrantia Theodorea, Boy Muchlis Bachtiar, Ade Fadly H Masse, Gamaliel Juliadi Biring, Handika Dwi Prasetyo. Visual novel game as a new breakthrough in dental health education media for stunted children in Indonesia. Journal of Clinical Pediatric Dentistry. 2026; 50(1): 245-254. doi: 10.22514/jocpd.2026.023.