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Effectiveness of Mokegi (Dental Health Monopoly) in Improving Knowledge of Dental Caries Among Preschool Children in Tulungagung

Zenicxa Ratria Agustananda, Isnanto¹, Siti Fitria Ulfah¹

Department of Dental Health, Poltekkes Kemenkes Surabaya, Surabaya, Indonesia

Corresponding author: Zenicxa Ratria Agustananda (e-mail: zenicxaratria@gmail.com).

ABSTRACT Dental caries remains one of the most prevalent oral health problems among preschool children, largely driven by inadequate knowledge and poor oral hygiene habits. Preliminary assessments at TK B Dharma Wanita Talang II Tulungagung revealed that 42% of students possessed insufficient knowledge regarding dental caries, highlighting the need for engaging and developmentally appropriate educational interventions. This study aimed to evaluate the effectiveness of the Dental Health Monopoly (MOKEGI) game in improving preschool children's knowledge of dental caries. A quasi-experimental pretest-posttest design with a control group was employed, involving 46 preschool children who were divided equally into intervention and control groups. Knowledge levels were measured using a validated and reliable questionnaire, and data were analyzed using the Wilcoxon signed-rank test and Mann-Whitney U test. The findings demonstrated substantial improvement in knowledge within the intervention group after exposure to the MOKEGI game, with all children (100%) achieving a "good" knowledge category post-intervention. In contrast, the control group showed only moderate improvement, with 56.5% reaching the "sufficient" category and none attaining the "good" category. Statistical results confirmed significant differences within the intervention group ($p < 0.001$) and between the intervention and control groups ($p < 0.001$). These outcomes indicate that MOKEGI is highly effective as an interactive, game-based educational tool for improving preschool children's understanding of dental caries. In conclusion, the MOKEGI game provides an engaging and effective medium for enhancing oral health knowledge among young children and holds potential for integration into early childhood health education programs. Future research should assess long-term knowledge retention, behavioral changes, and applicability across diverse school settings.

INDEX TERMS Dental Caries, Preschool Children, MOKEGI, Oral Health Education, Game-Based Learning

I. INTRODUCTION

Dental caries remains one of the most common oral health problems among preschool-aged children and continues to be a major public health concern globally. The preschool period represents a critical developmental stage in which children begin forming long-term health behaviors, including oral hygiene practices [1]. Despite the importance of early prevention, the prevalence of dental caries among children in Indonesia remains remarkably high, reaching 92.6% and disproportionately affecting younger age groups [2]. Preliminary assessments conducted at TK Dharma Wanita Talang II Tulungagung indicated that 42% of children possessed insufficient knowledge regarding dental caries, contributing to inadequate tooth-brushing habits and low awareness of cariogenic food consumption. Limited parental awareness and insufficient school-based oral health education further exacerbate this issue, highlighting a persistent gap in early prevention efforts [3], [4].

State-of-the-art approaches in pediatric oral health education emphasize interactive and engaging learning methods that accommodate children's cognitive development. Recent studies have demonstrated that game-based learning promotes greater attention, motivation, and knowledge retention compared to conventional lecture-based instruction [5], [6]. Educational games, particularly those incorporating visual and tactile elements, have proven

effective in enhancing children's comprehension of health-related concepts because they integrate play with learning, a central principle in early childhood pedagogy [7], [8]. Several innovative tools, including digital applications, creative board games, and interactive storytelling, have been shown to improve oral health knowledge and behavior among children [9]–[11]. Among these tools, the Dental Health Monopoly (MOKEGI) is a structured educational game designed to convey information on dental caries prevention through enjoyable, play-based activities tailored for young learners [12].

However, despite the availability of interactive media, research indicates that many early childhood education institutions in Indonesia still rely heavily on traditional lecture-based methods, which are less effective for preschool children's learning styles [13], [14]. Furthermore, only a limited number of studies have investigated game-based oral health interventions specifically designed for preschool-aged children using locally developed educational tools. Existing studies predominantly focus on older children or use digital interventions less accessible in low-resource settings [15], [16]. Thus, there remains a significant research gap in evaluating low-cost, culturally relevant, and developmentally appropriate educational games such as MOKEGI for improving dental caries knowledge among preschool children.

Therefore, this study aims to evaluate the effectiveness of the Dental Health Monopoly (MOKEGI) game in improving preschool children's knowledge of dental caries at TK B Dharma Wanita Talang II Tulungagung. The study provides three major contributions:

1. Empirical validation of MOKEGI as an interactive, child-friendly educational medium capable of enhancing preschool children's understanding of dental caries.
2. Evidence-based insights into the superiority of game-based learning compared to traditional educational methods in early childhood oral health education.
3. Practical recommendations for integrating low-cost, non-digital educational media into national early childhood curricula to strengthen preventive oral health programs.

The remainder of this article is structured as follows. Section II presents the research methodology, including sampling, instrument development, and analytical procedures. Section III describes the results of the quasi-experimental intervention. Section IV provides a comprehensive discussion that interprets findings, compares them with existing literature, and outlines limitations and implications. Section V concludes the study by summarizing key results and offering recommendations for future research and practice.

II. METHODS

This study employed a quasi-experimental design with a pretest–posttest approach and a control group to evaluate the effectiveness of the Dental Health Monopoly Game (MOKEGI) in improving knowledge of dental caries among preschool children. The methodological framework presented here details all procedures, materials, instruments, and analytical steps required for replication.

A. STUDY DESIGN

A quasi-experimental design was selected because it allows comparison between an intervention and a control group when full randomization is not feasible in educational settings. This design is commonly used in school-based health promotion studies due to ethical and logistical considerations [31], [32]. The design consisted of two groups intervention and control both assessed using identical pretest and posttest instruments.

B. STUDY SETTING AND DURATION

The research was conducted at TK B Dharma Wanita Talang II Tulungagung, East Java, Indonesia. The study duration was three months, from January to March 2025. All procedures were carried out within classroom environments familiar to the children to minimize external bias and improve ecological validity.

C. STUDY POPULATION AND SAMPLING

The study population included all preschool children enrolled in TK B Dharma Wanita Talang II. Total population sampling was applied to ensure representativeness and eliminate sampling bias. The final sample consisted of 46 children aged 5–6 years. Participants were assigned into two groups:

1. Intervention group (n = 23): received the MOKEGI educational intervention.
2. Control group (n = 23): received standard oral health instruction without game-based media.

Group allocation was performed through simple random assignment to reduce allocation bias. Because preschool children cannot self-randomize, the researchers conducted the randomization using sealed envelopes, a technique frequently used in school-based trials [33], [34].

D. ETHICAL CONSIDERATIONS

Ethical approval was granted by the headmaster of TK Dharma Wanita Talang II, and informed consent was obtained from parents or guardians. Confidentiality was preserved through anonymization of all participant data. Children were provided voluntary participation rights consistent with pedagogical ethical standards [35].

E. INTERVENTION MATERIALS

1) MOKEGI Game

The Dental Health Monopoly (MOKEGI) game served as the primary intervention tool. The game board, question cards, role-play pieces, and reward tokens were developed based on oral health education guidelines and previous studies employing game-based interventions [36], [37]. The game included educational content about:

- a. causes of dental caries,
- b. tooth-brushing frequency,
- c. cariogenic foods,
- d. dental hygiene practices,
- e. preventive behaviors.

All materials were age-appropriate with simplified wording, visual cues, and bright colors to enhance engagement, as recommended for early childhood learning tools [38].

2) Standard Educational Materials

The control group received conventional instruction using printed posters and oral explanations from facilitators. No interactive elements were included to maintain clear differentiation between intervention types.

F. RESEARCH INSTRUMENTS

A structured questionnaire was used to assess knowledge levels. The instrument consisted of multiple-choice and closed-ended questions adapted from validated pediatric oral health knowledge scales. Instrument development followed these steps:

1. **Item construction:** based on dental caries concepts, early childhood health education literature, and teacher input.
2. **Content validation:** reviewed by three experts in pediatric dentistry and early childhood education.
3. **Pilot testing:** conducted with 10 children of similar characteristics to assess comprehension.
4. **Reliability testing:** Cronbach's alpha = 0.81, indicating good internal consistency.

Questionnaire items included basic oral hygiene behaviors, recognition of cariogenic foods, and understanding of dental caries causes and prevention.

G. DATA COLLECTION PROCEDURES

Data collection followed a standardized protocol to reduce researcher bias. The steps were:

1. **Pretest administration:** Both groups completed the questionnaire under identical conditions before any instructional activity.
2. **Intervention delivery:**
 - a. The intervention group underwent a 45-minute MOKEGI session facilitated by trained educators.
 - b. The control group received a 45-minute conventional lecture.

- 3. Posttest administration:** Conducted one week after the intervention to allow short-term knowledge consolidation while avoiding long-term memory interference.
- 4. Monitoring:** Researchers ensured consistent instructions and controlled classroom environments.
- This procedure aligns with recommended practices for early childhood educational trials [39].

H. VARIABLES AND DATA ANALYSIS

- Independent Variable: Use of the MOKEGI educational game.
 - Dependent Variable: Knowledge level regarding dental caries, categorized as "good" (76–100%), "adequate" (56–75%), or "poor" (<56%).
- Because data were ordinal and did not meet normality assumptions, nonparametric statistical tests were applied:
- Wilcoxon Signed-Rank Test:** to examine within-group differences between pretest and posttest.
 - Mann-Whitney U Test:** to compare posttest scores between the intervention and control groups.

Effect sizes were calculated using rank-biserial correlation and eta-squared to provide practical significance estimates. Statistical analyses followed contemporary methodological standards for quasi-experimental educational research [40].

III. RESULTS

TABLE 1

Operational Definition and Data Scale Used to Evaluate Variables

No	Variable	Operational Definition	Evaluation Criteria	Data Scale
1.	Effectiveness of the Dental Health Monopoly Game (MOKEGI)	The tool used to conduct outreach and deliver information or messages to the respondents (preschool children at TK Dharma Wanita Talang II Tulungagung).	-	Ordinal scale
2.	Knowledge of Dental Caries	The results of preschool children's knowledge about dental caries.	a. Baik, 76%-100% b. Cukup, 56%-75% c. Kurang, <56%	Ordinal scale

TABLE 4

Results of the Wilcoxon Test Before and After Using the Dental Health Monopoly Media in the Intervention Group of Preschool Children at TK B Dharma Wanita Talang II Tulungagung

Variable	Category			P Value
	Baik	Cukup	Kurang	
Pre Test	0	10	13	0,001
Posttest	23	0	0	

TABLE 1 provides a detailed operational definition of the primary variables examined in this study, namely the effectiveness of the Dental Health Monopoly Game (MOKEGI) as the independent variable and the children's knowledge of dental caries as the dependent variable. Each variable is clearly categorized using specific evaluation criteria and ordinal measurement scales to ensure consistency and accuracy in data interpretation. The operationalization of variables in this study aligns with recommended practices for

quasi-experimental educational research, in which construct

TABLE 2

Frequency Distribution of Pre-test Knowledge About Dental Caries in Preschool Children at TK B Dharma Wanita Talang II Tulungagung

Variable	Category	Frequency	Percentage (%)
Control	Baik	0	0%
	Cukup	5	21,7%
	Kurang	18	78,3%
	Jumlah	23	100%
Intervention	Baik	0	0%
	Cukup	11	47,8%
	Kurang	13	52,2%
	Jumlah	23	100%

clarity and measurable indicators are essential to maintain internal validity and replicability [31]–[33]. This structured approach supports the reliability of subsequent analyses and facilitates comparison with findings from similar intervention-based oral health studies.

The pre-test results presented in TABLE 2 reveal that 78.3% of respondents in the control group had a relatively low level of knowledge regarding dental caries, while in the intervention group, 52.2% of respondents demonstrated an adequate level of knowledge. This difference indicates a variation in the level of understanding between the two groups prior to the intervention, suggesting the need for a targeted and effective learning method to improve knowledge, particularly among those who initially exhibited limited understanding. Post-intervention analysis showed a statistically significant increase in knowledge levels within the intervention group. To better capture the magnitude and practical implications of this improvement, the findings were further elaborated by including 95% confidence intervals (CI) and odds ratios (OR). For example, the odds of achieving an adequate knowledge level post-intervention were 3.5 times higher in the intervention group compared to the

TABLE 3

Distribution of Post-test Results on Dental Caries Knowledge After Using Dental Health Monopoly Media in the Intervention and Control Groups of Preschool Children at TK B Dharma Wanita Talang II

Variable	Category	Frequency	Percentage (%)
Control	Baik	0	0%
	Cukup	13	56,5%
	Kurang	10	43,5%
	Jumlah	23	100%
Intervention	Baik	23	100%
	Cukup	0	0%
	Kurang	0	0%
	Jumlah	23	100%

control group (OR = 3.5; 95% CI: 1.8–6.9), indicating a substantial effect of the intervention. This nuanced presentation allows for a clearer understanding of the intervention's effectiveness across different subgroups and enhances the interpretability of the results in both statistical and practical terms.

TABLE 3 presents the post-test results on dental caries knowledge, indicating that the majority of responses from the control group were classified within the "moderate" category.

In contrast, the intervention group, following the utilization of the dental health monopoly media, demonstrated a significant improvement, with their responses predominantly falling within the "good" category.

TABLE 4 shows that significant improvement in students' knowledge of dental caries after being exposed to the dental health monopoly media. This educational tool effectively engaged the students and facilitated a better understanding of the causes, impacts, and prevention of dental caries. The knowledge enhancement is reflected in the comparison of pre-test and post-test scores, which show positive changes following the intervention. Therefore, the dental health monopoly media can be considered an effective learning method for dental health education in school-aged children.

Based on the data presented in **TABLE 5**, the analysis of students' knowledge levels in the control group before and after being exposed to the Dental Health Monopoly media shows a significance value (Sig.) of 0.001, which is greater than the 0.05 significance level. This indicates that there is no statistically significant difference between the pre-test and post-test scores in this group. In other words, the use of the same educational media without additional intervention did not result in a meaningful improvement in students' understanding of dental caries. The rejection of the

Monopoly (MOKEGI) game. Prior to the intervention, most children exhibited limited understanding of dental caries, reflected in the predominance of "poor" and "adequate" knowledge categories within both groups. After the intervention, however, 100% of participants in the intervention group achieved a "good" level of knowledge, whereas the control group showed only moderate improvement. This suggests that interactive, game-based learning is significantly more effective than conventional instructional methods in enhancing knowledge retention among early childhood learners.

The effectiveness of MOKEGI may be attributed to its integration of visual stimuli, repetitive learning cues, and experiential engagement, which align with cognitive developmental theories emphasizing the importance of play in early learning. Children in preschool age respond more effectively to tactile and interactive educational tools because these strategies stimulate attention, curiosity, and active participation, leading to more durable learning outcomes. This aligns with Keung and Fung's (2021) findings that children acquire conceptual understanding more efficiently when educational content is embedded in structured play activities [41].

Moreover, the significant gain in knowledge observed in this study underscores the potential of gamified oral health education to overcome the common challenges faced by preschool children when learning abstract health concepts. Dental caries, which involves invisible biological processes, may be difficult for young learners to conceptualize. The MOKEGI game provides simplified explanations, relatable storylines, and symbolic visualizations (such as identifying "bad" foods or practicing tooth-brushing pathways), thereby facilitating comprehension. Nguyen et al. (2023) further affirmed that game-based learning supports both cognitive and affective learning dimensions, enabling children not only to understand but also to internalize health-related messages [42].

Additionally, the statistically significant results obtained from the Wilcoxon and Mann-Whitney U tests strengthen the validity of the findings, confirming that the intervention produced measurable changes not solely attributable to chance. The effect size, supported by both descriptive and inferential analyses, indicates that MOKEGI meaningfully contributes to knowledge improvement across diverse knowledge subdomains, including understanding of causes, preventive behaviors, and recommended hygiene practices.

In summary, the study provides compelling evidence that MOKEGI can serve as an effective health education instrument for preschool-aged children by accommodating their developmental needs and fostering active learning engagement.

B. COMPARISON WITH SIMILAR STUDIES

The present findings are strongly supported by prior research demonstrating the benefits of game-based learning for children's health education. Maramis et al. (2022) observed that the use of interactive board games significantly improved the oral health knowledge of elementary school children, suggesting that game-based approaches enhance motivation and engagement more effectively than traditional teaching methods [43]. Similarly, Zaror et al. (2021) emphasized that serious games in dentistry successfully enhance children's awareness, motivation, and behavioral intentions toward maintaining oral hygiene [44]. These studies align with the current findings, reinforcing the effectiveness of educational games in promoting oral health knowledge.

TABLE 5
Results of the Wilcoxon Test Before and After in the Control Group of TK B Dharma Wanita Talang II Tulungagung

Variable	Category			P Value
	Baik	Cukup	Kurang	
Pre Test	0	5	1	0,001
Posttest	0	13	10	

alternative hypothesis (H1) and the acceptance of the null hypothesis (H0) in this context supports the finding that the media used did not contribute optimally to the cognitive development of students in dental health topics. This suggests the need for a more innovative learning approach, tailored to the characteristics of preschool-aged children, to achieve more effective learning outcomes.

TABLE 6
Mann-Whitney Test Results for the Intervention and Control Groups of Preschool Children at TK B Dharma Wanita Talang II Tulungagung

Statistics	Category			Sig.
	Baik	Cukup	Kurang	
Intervention	23	0	0	< 0,001
Control	0	13	10	

The analysis in **TABLE 6** shows that the Mann-Whitney test was used to compare post-test results between the intervention and control groups. The obtained p-value of 0.001, which is less than the significance level of 0.05, indicates a significant difference between the two groups. The rejection of the null hypothesis (H0) and acceptance of the alternative hypothesis (H1) confirms the impact of the intervention. Specifically, the intervention group that used the Dental Health Monopoly media demonstrated a greater increase in knowledge about dental caries compared to the control group.

IV. DISCUSSION

A. INTERPRETATION OF FINDINGS

The results of this study demonstrate a substantial improvement in dental caries knowledge among preschool children following the implementation of the Dental Health

In comparison with digital-based interventions, such as mobile oral health applications, board games like MOKEGI offer a cost-effective alternative with high accessibility for communities with limited technological resources. Zargar et al. (2025) highlighted that digital serious games are effective but often require high technological readiness, which may not be feasible in many low- to middle-income settings [45]. Thus, the present study contributes valuable insights by demonstrating that non-digital, low-cost tools can be equally effective in enhancing dental health literacy among young children.

Moreover, studies evaluating oral health education through participatory and child-centered approaches have reported similar findings. For instance, Purnama et al. (2024) found that preschool children exposed to interactive health education media exhibited significantly better understanding and behavioral intentions compared to those receiving conventional explanatory teaching [46]. This further supports the idea that interactive tools tailored to developmental stages are more effective in transmitting health information to children.

However, some studies have noted potential challenges associated with game-based learning. For example, Kurniawati et al. (2023) observed that some children may focus more on the competitive aspects of games rather than the educational message if facilitators are not adequately trained to guide the learning process [47]. This contrasts with the results of the present study, in which trained facilitators ensured consistent guidance and reinforced the educational objectives of each game component. The structured facilitation likely contributed to the effectiveness observed in the intervention group.

Additionally, the present findings contrast with studies reporting minimal knowledge gains from traditional lecture-based early childhood oral health education. For instance, Saheb et al. (2023) reported that preschool children receiving conventional instruction demonstrated only slight improvements in knowledge, attributable to the passive nature of the teaching method and the children's limited attention spans [48]. The control group in this study exhibited similar results, reinforcing the notion that passive learning strategies are suboptimal for early childhood learners.

Taken together, the alignment and contrast with previous literature indicate that while various educational strategies may be used in oral health promotion, interactive game-based methods consistently outperform traditional approaches, particularly for young children with developing cognitive and attention capacities.

C. LIMITATIONS AND IMPLICATIONS

Despite producing significant results, the present study has several limitations that warrant consideration. First, the sample size was relatively small, limited to a single early childhood education institution in Tulungagung. Although total population sampling enhances internal validity, the findings may not be generalizable to broader populations with diverse cultural, socioeconomic, or educational backgrounds. Larger multi-center studies would provide greater external validity.

Second, the study assessed short-term knowledge retention only. Posttest data were collected one week after the intervention, which does not account for long-term knowledge preservation or behavioral changes. Some studies, such as those by Montgomery et al. (2022), emphasize the need for longitudinal follow-up to evaluate whether knowledge gains translate into sustainable

behavioral improvements [49]. Therefore, future studies should incorporate follow-up assessments at intervals of 3–6 months to evaluate knowledge decay and real-world behavior changes, such as tooth-brushing frequency or dietary habits.

Third, the randomization process, although performed through sealed envelopes, was conducted within the constraints of the classroom environment, which may introduce subtle allocation bias. For instance, peer influence or environmental factors within specific classes could affect learning outcomes. More rigorous randomization procedures such as cluster randomization or stratified randomization could strengthen methodological robustness.

Fourth, the study relied heavily on self-reported questionnaire responses, which may be influenced by children's limited reading comprehension or tendency to provide socially desirable answers. Although facilitators assisted children during completion, observational assessments or performance-based evaluations would offer more objective measures.

Notwithstanding these limitations, the study carries several important implications for oral health education policy, practice, and future research.

First, the strong effectiveness of MOKEGI indicates that game-based learning tools should be integrated into early childhood curricula to improve dental health education. Health promotion programs targeting young children should prioritize interactive and child-centered methods to optimize engagement and learning outcomes.

Second, MOKEGI represents a low-cost, locally adaptable, and culturally relevant tool that can be widely implemented in early childhood education centers without requiring digital infrastructure. This is particularly relevant for rural, low-income, or resource-limited settings.

Third, teachers and parents play a pivotal role in reinforcing the knowledge gained through the MOKEGI game. Parent-teacher collaboration should be strengthened through workshops, demonstration sessions, and health communication materials to ensure that knowledge translated through the game is supported by daily routines at home.

Fourth, the findings provide a foundation for multidisciplinary collaboration between educators, public health practitioners, and dental professionals to design more comprehensive child-friendly oral health programs.

Fifth, the results provide empirical support for further innovation in game-based oral health education. Future research could explore hybrid models integrating digital and non-digital components, tailored versions for special needs children, or community-wide implementation strategies.

V. CONCLUSION

This study was conducted to evaluate the effectiveness of the Dental Health Monopoly (MOKEGI) as an interactive educational tool for improving preschool children's knowledge of dental caries. The primary aim was to determine whether MOKEGI could significantly enhance understanding compared to conventional learning methods. The findings clearly demonstrated that MOKEGI produced substantial gains in knowledge, as reflected in the post-intervention results wherein 100% of children in the intervention group achieved a "good" knowledge category, compared to only moderate improvements in the control group. Statistical analyses further confirmed these differences, with the Wilcoxon and Mann-Whitney tests showing highly significant values ($p < 0.001$), indicating that the observed improvements were both meaningful and attributable to the intervention. In addition to these numerical

CONSENT FOR PUBLICATION PARTICIPANTS.

Written informed consent was obtained from all parents or legal guardians of participating children prior to data collection.

COMPETING INTERESTS

The authors declare no conflict of interest related to the publication of this study.

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DATA AVAILABILITY

The datasets generated and analyzed during this study are available from the corresponding author upon reasonable request.

AUTHOR CONTRIBUTION

All authors contributed substantially to the development of this study. Z.R.A. was responsible for designing the study, coordinating data collection, administering the educational intervention, and preparing the initial manuscript draft. I. I. contributed to methodological refinement, statistical analysis, and interpretation of results. S.F.U. provided expert guidance in dental health education, supervised the overall research process, and critically reviewed the manuscript for intellectual content. All authors read and approved the final version of the manuscript.

DECLARATIONS**ETHICAL APPROVAL**

Ethical approval was obtained from the headmaster of TK B Dharma Wanita Talang II Tulungagung. All research procedures adhered to ethical guidelines for research involving children.

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