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Enhancing Toothbrushing Skills in Preschool Children: A Comparative Study of Counseling Using the Storytelling Method with Dental Phantom Media

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ABSTRACT Dental caries remains a significant public health concern among preschool children, with prevalence rates reaching 93% in Indonesia as of 2018, substantially impacting children's quality of life through pain, discomfort, and developmental complications. Despite the established effectiveness of proper toothbrushing in preventing dental caries, many preschool children demonstrate inadequate brushing techniques, necessitating innovative educational approaches to enhance their oral hygiene skills. This study aimed to evaluate the effectiveness of counseling using storytelling methodology combined with dental phantom media on improving toothbrushing skills among preschool children. A quasi-experimental study with pre-post design was conducted among 32 students aged 5-6 years at Kindergarten Islam Plus Al Haqiqi Surabaya between January and February 2023. Participants' toothbrushing skills were assessed using structured observation sheets before and after intervention, with the intervention consisting of storytelling sessions incorporating dental phantom media delivered over two 50-minute sessions. Toothbrushing skills were categorized as good (4-5 correct movements), moderate (2-3 correct movements), or poor (0-1 correct movements), and statistical analysis employed the Wilcoxon signed-rank test to determine intervention effectiveness. Pre-intervention assessment revealed that 93.8% (n=30) of participants demonstrated poor toothbrushing skills, while only 6.2% (n=2) exhibited moderate skills. Following the storytelling intervention with dental phantom media, all participants (100%, n=32) achieved good toothbrushing skills, with mean skill scores significantly improving from 1.06±0.24 pre-intervention to 3.00±0.00 post-intervention ($p<0.001$). Storytelling methodology combined with dental phantom media demonstrates significant effectiveness in enhancing toothbrushing skills among preschool children, offering a promising strategy for improving pediatric oral health outcomes and preventing early childhood caries through engaging, age-appropriate instruction that facilitates skill acquisition and retention.

INDEX TERMS Preschool children, Toothbrushing skills, Storytelling method, Dental health education, Oral hygiene.

I. INTRODUCTION

Early childhood caries (ECC) represents one of the most prevalent chronic diseases affecting children globally, constituting a significant public health challenge that demands urgent attention [1]-[3]. Recent systematic reviews demonstrate that early childhood caries affects almost half of preschool children worldwide, with substantial geographical variations in prevalence rates [4]. In developing countries, particularly in Asia, the burden of dental caries among preschool children remains alarmingly high, with Indonesia reporting prevalence rates of 93% in 2018, indicating that only 7% of young children remain caries-free [5], [6]. Contemporary cross-sectional studies across various populations continue to report concerning prevalence rates, with some regions showing dental caries affecting over 80% of preschool children [7]-[9]. The consequences of untreated dental caries extend beyond oral health, significantly impacting children's quality of life through pain, discomfort, feeding difficulties, sleep disturbances, and impaired cognitive development, ultimately leading to reduced learning capacity and increased healthcare costs [10], [11].

Traditional approaches to pediatric oral health education have predominantly relied on conventional didactic methods, including lectures, demonstrations, and printed materials [12], [13]. However, recent advances in health education have emphasized the importance of age-appropriate, engaging methodologies that align with children's developmental characteristics and learning preferences [14], [15]. Contemporary research has demonstrated the effectiveness of storytelling as an innovative pedagogical approach for oral

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health education among preschool children, with evidence showing improved knowledge retention and behavioral changes [16]-[18]. Interactive educational interventions utilizing multimedia approaches, including puppet shows, role-playing, and digital storytelling, have emerged as promising alternatives to traditional methods [19], [20]. Furthermore, the integration of visual aids and tactile learning experiences through dental phantom models has shown enhanced learning outcomes in dental health education programs [21], [22]. Social story-based interventions have also demonstrated efficacy in improving oral health-related behaviors among children with special healthcare needs [23], [24].

Despite the documented effectiveness of various educational approaches, limited research has systematically evaluated the combined impact of storytelling methodology with dental phantom media specifically targeting toothbrushing skill development in preschool children. Most existing studies have focused either on knowledge acquisition or attitude changes rather than practical skill demonstration and retention [25], [26]. Additionally, there is insufficient evidence regarding the optimal duration and format of storytelling interventions for maximizing toothbrushing competency among preschool populations [27]. The lack of standardized assessment tools for evaluating practical toothbrushing skills following educational interventions further compounds this research gap [28].

This study aims to evaluate the effectiveness of counseling using storytelling methodology combined with dental phantom media on enhancing toothbrushing skills among preschool children in an Indonesian kindergarten setting. This research contributes to the existing body of knowledge in three significant ways:

1. It provides empirical evidence for the effectiveness of an integrated educational approach combining storytelling with hands-on learning through dental phantom media, offering a novel pedagogical framework for pediatric oral health education.
2. The study establishes a standardized assessment protocol for evaluating practical toothbrushing skills in preschool children, contributing to the development of reliable measurement tools for future research and clinical applications.
3. The findings offer practical insights for healthcare educators, dental professionals, and policymakers in developing culturally appropriate, evidence-based oral health promotion programs specifically tailored for preschool populations in resource-limited settings.

The remainder of this article is organized as follows: Section II presents the research methodology, including study design, participants, intervention protocol, and statistical analysis approaches. Section III reports the research findings, presenting descriptive statistics and comparative analyses of pre- and post-intervention toothbrushing skills. Section IV provides a comprehensive discussion of the results, comparing findings with existing literature and exploring implications for clinical practice. Finally, Section V concludes the study with key findings, limitations, and recommendations for future research directions.

II. METHODS

This section presents the methodological framework for investigating the effectiveness of storytelling-based oral health education combined with dental phantom media in enhancing toothbrushing skills among preschool children. The research design addresses the primary objective of evaluating behavioral skill acquisition while maintaining methodological rigor and ethical considerations appropriate for pediatric populations. A quasi-experimental pretest-posttest design was selected to balance scientific validity with practical constraints inherent in educational intervention studies involving young children. The methodology encompasses participant selection procedures, intervention protocols, standardized assessment instruments, and statistical analysis approaches. Each component was designed to ensure reliability and validity while addressing potential limitations in pediatric behavioral research.

A. STUDY DESIGN AND SETTING

This investigation employed a quasi-experimental design utilizing a single-group pretest-posttest framework to evaluate the efficacy of storytelling-based oral health education intervention [29]. The study was conducted at Kindergarten Islam Plus Al Haqiqi Surabaya, Indonesia, during the period from January to February 2023. This educational institution was selected through purposive sampling based on its accessibility, administrative cooperation, and representative demographic characteristics of urban preschool populations in East Java [30].

The quasi-experimental approach was deemed appropriate for this educational intervention study due to ethical considerations preventing random allocation of children to control groups that would be deprived of potentially beneficial oral health education [31]. This design allows for the assessment of intervention effects while maintaining the practical and ethical integrity of the educational setting [32].

B. PARTICIPANTS AND SAMPLING

The study population comprised all enrolled students at Kindergarten Islam Plus Al Haqiqi Surabaya, totaling 32 children aged 5-6 years. The sample size was determined through total population sampling, where all eligible participants were included in the study to maximize statistical power and ensure representativeness of the target demographic [33].

Inclusion criteria were established as follows: (1) children aged 5-6 years enrolled in the kindergarten; (2) present during both data collection phases; (3) capable of following basic instructions; and (4) parental consent obtained. Exclusion criteria included: (1) children with developmental disabilities that would impair comprehension or motor skills; (2) absence during intervention sessions; and (3) lack of parental consent.

The demographic composition of the sample included 18 female participants (56.2%) and 14 male participants (43.8%), with 22 children (68.8%) aged 6 years and 10 children (31.2%)

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aged 5 years. This distribution reflects typical kindergarten enrollment patterns in Indonesian urban settings.

C. INTERVENTION PROTOCOL

The educational intervention was implemented through a structured storytelling methodology enhanced with dental phantom media, delivered over two sessions of approximately 50 minutes each. The intervention was designed based on social cognitive theory principles, emphasizing observational learning and behavioral modeling [34].

1. STORYTELLING COMPONENT

Professional storytellers, trained in pediatric communication techniques, delivered narratives specifically designed to promote proper toothbrushing behaviors. The stories incorporated characters and scenarios relevant to Indonesian cultural context, featuring age-appropriate language and engaging plotlines that emphasized the importance of oral hygiene practices.

2. DENTAL PHANTOM MEDIA

Three-dimensional dental models were utilized to demonstrate proper toothbrushing techniques, allowing children to observe and practice correct brushing motions, pressure application, and systematic tooth surface coverage. The phantom models provided tactile learning experiences that complemented the auditory storytelling component.

3. SESSION STRUCTURE

Each session followed a standardized protocol: (1) 15-minute storytelling presentation; (2) 20-minute interactive demonstration using dental phantoms; (3) 10-minute supervised practice session; and (4) 5-minute question-and-answer period for clarification and reinforcement.

D. DATA COLLECTION INSTRUMENTS

Toothbrushing skills were assessed using a standardized observational checklist developed specifically for preschool populations [35]. The assessment instrument evaluated five critical components of proper toothbrushing technique: (1) appropriate toothbrush handling; (2) correct toothpaste application; (3) systematic brushing motion across all tooth surfaces; (4) adequate brushing duration; and (5) proper rinsing technique.

Each component was scored using a binary system (1 = correct execution, 0 = incorrect execution), yielding a maximum possible score of 5 points per participant. Scoring categories were established as follows: good performance (4-5 correct movements), moderate performance (2-3 correct movements), and poor performance (0-1 correct movements). This classification system has been validated in previous pediatric oral health research and demonstrates appropriate sensitivity for detecting intervention effects [36].

E. DATA COLLECTION PROCEDURES

Data collection was conducted in three phases: baseline assessment (pretest), intervention delivery, and post-intervention assessment (posttest). All assessments were performed by trained research assistants who were blinded to the study hypotheses to minimize observer bias.

1. PRETEST PHASE

Individual toothbrushing skill assessments were conducted in a standardized clinical setting within the school premises. Each child was provided with identical toothbrushing materials and asked to demonstrate their typical toothbrushing routine while being observed and scored according to the assessment checklist.

2. INTERVENTION PHASE

The storytelling intervention was delivered to small groups of 8-10 children to ensure adequate attention and participation. All sessions were conducted in the school's multimedia room, equipped with appropriate audiovisual equipment and sufficient space for hands-on activities with dental phantoms.

3. POSTTEST PHASE

Follow-up assessments were conducted 48 hours after the completion of the intervention to allow for skill consolidation while minimizing the potential for skill degradation over time. The assessment protocol remained identical to the pretest phase to ensure measurement consistency.

F. STATISTICAL ANALYSIS

Data analysis was performed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were calculated for demographic characteristics and toothbrushing skill scores. The primary outcome analysis employed the Wilcoxon signed-rank test to compare pre- and post-intervention toothbrushing skill scores, as the data demonstrated non-normal distribution characteristics confirmed through Shapiro-Wilk testing [37].

The significance level was set at $\alpha = 0.05$ for all statistical tests. Effect size calculations were performed using Cohen's conventions for non-parametric tests to quantify the magnitude of intervention effects. All analyses were conducted according to intention-to-treat principles, with no participants lost to follow-up during the study period.

G. ETHICAL CONSIDERATIONS

This study was conducted in accordance with the Declaration of Helsinki and received approval from the institutional review board. Written informed consent was obtained from parents or legal guardians of all participants prior to data collection. Additionally, verbal assent was obtained from all child participants before conducting assessments. Confidentiality was maintained through the use of coded identifiers, and all data were stored in secure, password-protected databases accessible only to authorized research personnel.

III. RESULTS

Based on the data presented in TABLE 1, it can be concluded that the majority of respondents in this study were women (56.2%), while only a small proportion of respondents were male (43.8%). In terms of age, most of the respondents were 6 years old (68.8%), while only a small number of respondents were 5 years old (31.2%). Based on

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TABLE 2, the results of the teeth brushing skills category before receiving counseling, the majority of respondents' brushing skills were in the bad category (93.8%), and a small number were in the medium category (6.2%).

TABLE 1
Characteristics of Respondents

Characteristics of Respondent	Frequency N	Percentage %
Gender		
Boy	14	43,8
Girl	18	56,2
Total	32	100
Age		
5 years old	10	31,2
6 years old	22	68,8
Total	32	100

TABLE 2
Results Category Skills Brushing Teeth Before Intervention

Tooth brushing skills category	Frequency N	Percentage %
Good	0	0
Moderate	2	6,2
Bad	30	93,8
Total	32	100

TABLE 3
Results Category Skills of Brushing Teeth After Intervention

Tooth brushing skills category	Frequency N	Percentage %
Good	32	100
Moderate	0	0
Bad	0	0
Total	32	100

Based on TABLE 3, the results of the teeth brushing skills category after receiving counseling, the teeth brushing skills category after counseling, all respondents were in the good category (100%).

TABLE 4
Counseling on the Storytelling Method Using Dental Phantom Media on the Teeth Brushing Skills of Preschool Children

Tooth Brushing Skills	Mean±SD	ρ
Before	1,06±0,24	0.000
After	3,00±0,00	

Based on TABLE 4, a ρ value of 0.000 is obtained so that H1 is accepted and H0 is rejected, it can be concluded that there is an influence of the storytelling method counseling with dental phantom media on the teeth brushing skills of preschool children in Kindergarten Islam Plus Al Haqiqi Surabaya.

IV. DISCUSSION

The findings of this quasi-experimental study demonstrate a statistically significant improvement in toothbrushing skills among preschool children following the implementation of storytelling-based oral health education combined with dental phantom media ($\rho = 0.000$, $p < 0.05$). The magnitude of improvement, evidenced by the transformation from predominantly poor performance categories (93.8% baseline) to universal good performance (100% post-intervention), represents a substantial behavioral change that warrants careful theoretical consideration. The observed improvement aligns with the principles of Social Cognitive Theory, which posits that learning occurs through the dynamic interaction of behavioral, personal, and environmental factors [38]. In the context of this intervention, the storytelling component addressed the personal cognitive factors by enhancing knowledge and motivation, while the dental phantom media provided environmental scaffolding for skill acquisition through observational learning and guided practice. The behavioral component was directly targeted through structured practice sessions that allowed children to demonstrate and refine their toothbrushing techniques under supervision. The mean score progression from 1.06 ± 0.24 to 3.00 ± 0.00 indicates not only statistical significance but also practical significance in terms of skill acquisition. This improvement suggests that the intervention successfully addressed the fundamental challenges in pediatric oral health education, particularly the translation of theoretical knowledge into practical motor skills [39]. The elimination of variability in post-intervention scores (SD = 0.00) demonstrates the intervention's effectiveness in achieving consistent skill mastery across all participants, regardless of baseline performance levels. From a developmental psychology perspective, the success of this intervention reflects the appropriateness of storytelling as a pedagogical approach for preschool children, whose cognitive development is characterized by concrete operational thinking and high receptivity to narrative-based learning [40]. The integration of visual, auditory, and kinesthetic learning modalities through the combined storytelling and phantom media approach likely contributed to enhanced encoding and retention of the target behaviors.

The results of this study demonstrate remarkable consistency with recent investigations examining innovative oral health education methodologies in pediatric populations. Shruti et al. [41] reported similar effectiveness of storytelling interventions in improving oral health knowledge and practices among preschool children, with significant pre-post intervention differences ($p < 0.001$). However, their study focused primarily on knowledge acquisition rather than practical skill demonstration, suggesting that the current study's emphasis on behavioral outcomes provides complementary evidence for the comprehensive effectiveness of storytelling approaches. Ashtarian et al. [42] conducted a comparative analysis of storytelling versus role-playing interventions for toothbrushing education in preschool children, reporting significant improvements in both groups with no statistically significant difference between methodologies. Their findings support the general efficacy of narrative-based educational approaches while highlighting the importance of interactive elements in pediatric health education. The current study extends these findings by demonstrating that the addition of tactile learning components through dental phantom media can achieve universal skill mastery, potentially representing an enhancement over purely verbal or visual interventions. In contrast to traditional didactic approaches, Chen et al. [43] demonstrated that conventional lecture-based oral health education showed modest improvements in knowledge scores but limited transfer to practical behaviors among similar age groups. Their findings

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underscore the superiority of experiential learning approaches, particularly for motor skill acquisition in young children. The current study's achievement of 100% skill mastery represents a substantial advancement over conventional educational methodologies, suggesting that the integration of storytelling with hands-on practice may be essential for optimal learning outcomes. International evidence from Gozin et al. [44] in Iranian populations and Kim et al. [45] in Korean settings demonstrates the cross-cultural applicability of storytelling interventions in oral health education. Both studies reported significant improvements in dental anxiety reduction and knowledge acquisition, respectively, supporting the universal appeal and effectiveness of narrative-based approaches across diverse cultural contexts. The current study contributes to this growing international evidence base while specifically addressing the Indonesian educational context and emphasizing practical skill development. However, some studies have reported more modest effects of educational interventions on long-term behavior maintenance. Wong et al. [46] found that while immediate post-intervention improvements were substantial, effect sizes diminished over 6-month follow-up periods without reinforcement activities. This finding highlights a potential limitation of single-session interventions and suggests the need for longitudinal assessment of the current study's outcomes.

Several methodological limitations must be acknowledged in interpreting these findings. The quasi-experimental design without a control group limits the ability to attribute observed changes exclusively to the intervention, as maturation effects, testing effects, or concurrent experiences could potentially contribute to the observed improvements [47]. The absence of randomization and the single-group design compromise the internal validity of causal inferences, representing a significant constraint on the generalizability of findings. The immediate post-intervention assessment (48 hours) provides limited insight into the durability of skill acquisition and behavioral maintenance over extended periods. Research in pediatric health education consistently demonstrates that initial learning gains may not persist without ongoing reinforcement, suggesting that the current findings may overestimate long-term intervention effectiveness. Additionally, the assessment was conducted in a structured school environment, which may not accurately reflect children's toothbrushing performance in their natural home settings where parental supervision and environmental cues differ substantially. The sample was drawn from a single kindergarten in an urban Indonesian setting, limiting the external validity and generalizability to diverse socioeconomic, cultural, and geographical contexts. The homogeneous sample characteristics, while ensuring internal consistency, restrict the applicability of findings to broader pediatric populations with varying educational backgrounds, resources, and cultural practices. Observer bias represents another potential limitation, as the research assistants conducting assessments were not blinded to the study timeline, though they were blinded to study hypotheses. The binary scoring system, while facilitating reliable assessment, may lack the sensitivity to detect subtle improvements in technique quality or partial skill acquisition that could be clinically meaningful.

The findings have significant implications for pediatric oral health promotion strategies and educational policy development. The demonstrated effectiveness of storytelling combined with hands-on learning provides evidence-based support for incorporating narrative-based methodologies into routine oral health education programs in educational settings. Healthcare providers and dental professionals should consider adopting similar multi-modal approaches when designing preventive interventions for preschool populations. From a public health perspective, the intervention's ability to achieve universal skill mastery suggests potential for substantial population-level impact if implemented systematically across educational institutions. Given the high prevalence of early childhood caries in Indonesia (93%), interventions that can reliably improve preventive behaviors across entire age cohorts represent valuable tools for addressing this significant public health challenge. The cost-effectiveness of the intervention, utilizing readily available materials and trained personnel, suggests feasibility for implementation in resource-limited settings characteristic of many developing countries. The scalability of storytelling interventions, combined with the standardized nature of dental phantom media, provides a replicable framework for broader dissemination.

Longitudinal studies with extended follow-up periods are essential to establish the durability of skill acquisition and identify optimal reinforcement strategies for maintaining behavioral changes. Randomized controlled trials incorporating control groups receiving standard oral health education would strengthen causal inferences and provide more robust evidence for intervention effectiveness. Investigation of dose-response relationships, examining optimal intervention duration, frequency, and reinforcement schedules, would inform evidence-based implementation guidelines. Additionally, comparative effectiveness research examining different narrative themes, cultural adaptations, and technology-enhanced delivery methods could optimize intervention design for diverse populations. Future studies should incorporate objective measures of oral health outcomes, such as plaque indices and caries incidence, to establish the clinical significance of improved toothbrushing skills. Parent-report measures and home-based assessments would provide valuable insights into the ecological validity of school-based skill acquisition and transfer to natural environments.

V. CONCLUSION

This study aimed to analyze the effect of counseling utilizing the storytelling method, complemented by dental phantom media, on enhancing the toothbrushing skills of preschool children. The findings of this quasi-experimental research, conducted with 32 students aged 5-6 years at Kindergarten Islam Plus Al Haqiqi Surabaya, unequivocally demonstrate a significant positive impact of the intervention. Prior to the counseling, the mean toothbrushing skill score was 1.06±0.24, with a staggering 93.8% of participants categorized as having "bad" toothbrushing skills and only 6.2% in the "moderate"

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category. Following the intervention, a remarkable improvement was observed, with the mean score increasing to 3.00±0.00 and 100% of the participants achieving a "good" category for their toothbrushing skills. The Wilcoxon test results, yielding a ρ-value of 0.000 ($p < 0.05$), provide compelling statistical evidence of the effectiveness of the storytelling method with dental phantom media in improving toothbrushing skills among preschoolers. This significant increase in skills underscores the suitability of the storytelling method for preschool-aged children and its potential to substantially improve oral health maintenance. By enabling children to brush their teeth properly, this approach plays a crucial role in preventing future dental caries. Future research could explore the long-term sustainability of these improved toothbrushing skills and investigate the impact of varied storytelling narratives and alternative educational media to further optimize oral hygiene interventions in early childhood. Additionally, studies incorporating a control group and larger sample sizes across diverse demographic settings would strengthen the generalizability of these findings and contribute to a more comprehensive understanding of effective dental health education strategies for preschoolers.

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DATA AVAILABILITY

No datasets were generated or analyzed during the current study.

AUTHOR CONTRIBUTION

Silvia Prasetyowati was responsible for the conceptualization and design of the study, overall project supervision, and played a primary role in the writing of the original draft and final manuscript review. Tara Tuhfatul Ayu Bakta and Agus Marjianto were instrumental in the development of the methodology, data acquisition, and data analysis. They also contributed to the original draft preparation. Anshad Ansari contributed to the critical review and editing of the manuscript, providing valuable intellectual input.

DECLARATIONS

ETHICAL APPROVAL

Ethical oversight for this research was meticulously adhered to, with the study proceeding in full compliance with the Declaration of Helsinki and securing requisite approval from the pertinent institutional review board. Prior to any data collection, comprehensive written informed consent was diligently acquired from the parents or legal guardians of all participating individuals. Furthermore, to ensure the autonomy of the younger participants, verbal assent was respectfully obtained from each child before the commencement of any assessments. Participant confidentiality was rigorously upheld throughout the study by employing coded identifiers, and all collected data were securely stored in password-protected databases, with access strictly limited to authorized research personnel.

CONSENT FOR PUBLICATION PARTICIPANTS.

Consent for publication was given by all participants.

COMPETING INTERESTS

The authors declare no competing interests.

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