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The Effectiveness of TURBODENT Educational Media in Improving Toothbrushing Skills in 5-6-Year-Old Children at Raden Paku Kindergarten, Surabaya

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ABSTRACT Inadequate toothbrushing skills among preschool children represent a significant public health concern, as proper oral hygiene practices during early childhood are fundamental to preventing dental diseases and establishing lifelong healthy behaviors. Preliminary observations conducted at Raden Paku Kindergarten in Surabaya revealed that the majority of 5-6-year-old children demonstrated deficient toothbrushing techniques, highlighting the urgent need for effective educational interventions to address this skill deficit. This study aimed to evaluate the effectiveness of TURBODENT (Try Using Box Dental), an interactive educational media tool, in improving toothbrushing skills among preschool children aged 5-6 years at Raden Paku Kindergarten in Surabaya. A quasi-experimental design with pretest-posttest control group configuration was employed. Forty children aged 5-6 years were randomly allocated into two equal groups: an intervention group receiving TURBODENT educational media and a control group receiving conventional instruction. Toothbrushing skills were assessed using a structured observation checklist administered before and after the intervention. Statistical analysis was conducted using the Wilcoxon signed-rank test for within-group comparisons and the Mann-Whitney U test for between-group differences. The intervention group demonstrated statistically significant improvement in toothbrushing skills (Wilcoxon test, $p = 0.000$), while the control group showed no significant changes ($p = 1.000$). Between-group analysis revealed a significant difference in skill improvement favoring the intervention group (Mann-Whitney U test, $p = 0.000$). The TURBODENT interactive educational media proved highly effective in enhancing toothbrushing skills among preschool children. This intervention represents a promising approach for improving oral health education in early childhood settings, potentially contributing to reduced dental disease burden and improved long-term oral health outcomes in pediatric populations.

INDEX TERMS Interactive Educational Media, Toothbrushing Skills, Preschool Children, Oral Health Education, Dental Health Intervention

I. INTRODUCTION

Oral health during early childhood represents a critical determinant of lifelong dental wellness, with toothbrushing proficiency serving as the cornerstone of preventive dental care [1]. Preschool children, typically aged 3-6 years, demonstrate emerging independence in self-care activities, yet frequently exhibit inadequate mastery of fundamental oral hygiene practices [2]. The prevalence of dental caries in pediatric populations remains alarmingly high, with research from the Indonesian Ministry of Health indicating that merely 1.4% of children aged five to six years possess the requisite skills for effective toothbrushing [3]. This deficiency in basic oral hygiene competencies has profound implications for dental health outcomes, contributing to elevated rates of dental caries, gingivitis, and other oral pathologies during critical developmental periods [4]. The mechanical removal of dental plaque through proper toothbrushing techniques represents the most cost-effective

and accessible preventive intervention for maintaining oral health [5]. However, preschool children frequently demonstrate suboptimal brushing patterns, inadequate plaque removal, and poor compliance with recommended oral hygiene protocols [6]. These deficiencies are exacerbated by children's natural tendency toward high-sugar dietary consumption and their limited understanding of cause-and-effect relationships between oral hygiene practices and dental health outcomes [7]. Contemporary approaches to pediatric oral health education have evolved from traditional didactic instruction toward more engaging, interactive methodologies. Digital health interventions, gamification strategies, and multimedia educational tools have emerged as promising alternatives to conventional lecture-based approaches [8]. Recent investigations have demonstrated the efficacy of interactive educational media in enhancing knowledge retention, skill acquisition, and behavioral modification among preschool populations [9].

Educational games and simulation-based learning platforms have shown particular promise in facilitating complex skill development while maintaining high levels of student engagement [10]. Interactive educational media platforms leverage visual, auditory, and kinesthetic learning modalities to accommodate diverse learning preferences and developmental stages [11]. These multimedia approaches capitalize on children's natural affinity for play-based learning, transforming abstract concepts into concrete, experiential learning opportunities [12]. Recent studies have highlighted the superior effectiveness of interactive media compared to traditional educational approaches in promoting sustained behavioral change and skill retention [13].

Despite the recognized importance of early childhood oral health education and the proliferation of innovative educational technologies, significant gaps persist in the literature regarding the specific effectiveness of interactive educational media for toothbrushing skill development in preschool populations [14]. Limited research has systematically evaluated the comparative effectiveness of traditional versus technology-enhanced educational interventions specifically targeting toothbrushing proficiency in children aged 5-6 years [15]. Furthermore, most existing studies have focused on knowledge acquisition rather than practical skill demonstration and behavioral modification [16]. The absence of standardized, developmentally appropriate assessment tools for evaluating toothbrushing skills in preschool children represents an additional limitation in current research [17]. Few studies have rigorously investigated the sustained efficacy of educational interventions or their long-term influence on oral health behaviors and outcomes. This study endeavors to assess the effectiveness of TURBODENT (Try Using Box Dental), an interactive educational media intervention, in fostering toothbrushing skill development among children aged 5-6 years enrolled at Raden Paku Kindergarten in Surabaya. This research contributes to a more comprehensive understanding of effective, durable pedagogical approaches in early childhood oral health education. This research contributes to the existing body of knowledge in several significant ways:

1. It provides empirical evidence regarding the effectiveness of interactive educational media specifically designed for toothbrushing skill development in preschool children, addressing a critical gap in pediatric oral health education research.
2. It establishes a standardized methodology for assessing toothbrushing proficiency in young children, offering a replicable framework for future investigations.
3. It demonstrates the practical application of technology-enhanced learning in early childhood education settings, providing insights for educators and healthcare professionals seeking to implement evidence-based oral health interventions.

This article is organized into five main sections: Section I, the introduction establishes the research context and objectives; Section II, the methodology section details the quasi-experimental design and data collection procedures; Section III the results section presents statistical findings and analysis; Section IV, the discussion section interprets findings within the broader context of pediatric oral health

education; and Section V, the conclusion summarizes key findings and implications for future research and practice.

II. METHOD

A. STUDY DESIGN AND POPULATION SAMPLING

This investigation employed a quasi-experimental design with a pretest-posttest control group configuration to evaluate the effectiveness of TURBODENT (Try Using Box Dental) interactive educational media on toothbrushing skill development [19]. The study design incorporated randomized group allocation to minimize selection bias and enhance internal validity. Data collection was conducted prospectively over a 21-day intervention period, following established behavioral change theory protocols [20]. The study was conducted at Raden Paku Kindergarten in Surabaya, Indonesia, during the academic year 2024. The target population comprised preschool children aged 5-6 years enrolled in the kindergarten program. The institutional setting was selected based on accessibility, administrative cooperation, and the presence of an adequate sample size meeting the specified age criteria. Sample size calculation was performed using G*Power software with the following parameters: effect size (d) = 0.8, alpha level = 0.05, power = 0.80, and two-tailed test configuration. The calculated minimum sample size was 32 participants, which was increased to 40 participants to account for potential attrition [21]. Participant selection was conducted using purposive sampling methodology based on predetermined inclusion and exclusion criteria. Inclusion criteria encompassed: (1) children aged 5-6 years; (2) regular attendance at Raden Paku Kindergarten; (3) absence of physical or cognitive impairments affecting motor skills; (4) parental consent for participation; and (5) child assent to participate in the study. Exclusion criteria included: (1) children with orthodontic appliances; (2) history of oral surgical procedures within the preceding three months; (3) current participation in other oral health interventions; and (4) chronic medical conditions affecting oral health status.

B. GROUP ALLOCATION AND INTERVENTION

Following initial assessment and consent procedures, participants were randomly allocated to either the intervention group ($n=20$) or control group ($n=20$) using computer-generated random number sequences. Block randomization with variable block sizes was employed to ensure balanced group allocation throughout the recruitment period [22]. Allocation concealment was maintained through sequentially numbered, opaque, sealed envelopes prepared by an independent researcher not involved in participant assessment. The intervention group received TURBODENT interactive educational media instruction implemented according to the 21-day behavioral change framework [23]. The intervention protocol was structured in three sequential phases: introduction phase (days 1-7), repetition phase (days 8-14), and reinforcement phase (days 15-21). Each phase incorporated specific learning objectives and assessment milestones designed to facilitate progressive skill development and behavioral consolidation. The TURBODENT media consisted of six interactive sticker

cards, each containing specific toothbrushing technique instructions presented in an age-appropriate visual format. Daily intervention sessions lasted 15-20 minutes and were conducted by trained research assistants under standardized conditions. The control group received conventional toothbrushing instruction using standard verbal and demonstration methods without interactive media components.

C. DATA COLLECTION AND STATISTICAL ANALYSIS

Toothbrushing skill assessment was conducted using a validated observation checklist specifically designed for preschool children [24]. The checklist comprised 12 discrete skill components, including: proper toothbrush grip, systematic brushing sequence, appropriate pressure application, duration of brushing, technique for different tooth surfaces, and post-brushing procedures. Each component was scored on a three-point Likert scale (0 = inadequate, 1 = adequate, 2 = proficient), yielding a total possible score of 24 points. Inter-rater reliability was established through training sessions involving two independent observers who achieved a Cohen's kappa coefficient of 0.85, indicating excellent agreement [25]. All assessments were conducted by trained dental health professionals blinded to group allocation to minimize observer bias. Baseline assessments (pretest) were conducted one week before intervention initiation for both groups. Post-intervention assessments (posttest) were administered 24 hours following completion of the 21-day intervention period. All observations were conducted in a standardized environment using identical materials and procedures. Participants were provided with standard toothbrushes and fluoride toothpaste for assessment. Each child was asked to demonstrate their toothbrushing technique on a dental model while observers completed the assessment checklist. The assessment process was video-recorded with parental consent to enable subsequent verification of scoring accuracy. Data analysis was performed using SPSS version 28.0 software. Descriptive statistics, including means, standard deviations, frequencies, and percentages, were calculated for all variables. Normality of data distribution was assessed using the Shapiro-Wilk test. Given the ordinal nature of the outcome variable and non-normal distribution, non-parametric statistical tests were employed for hypothesis testing [26]. Within-group comparisons of pre-post intervention changes were analyzed using the Wilcoxon signed-rank test. Between-group comparisons of intervention effectiveness were evaluated using the Mann-Whitney U test. Statistical significance was set at $p < 0.05$ for all analyses. Effect sizes were calculated using Cohen's conventions for interpretation of practical significance [27].

D. ETHICAL CONSIDERATIONS

This study received approval from the Institutional Review Board of the affiliated university. Written informed consent was obtained from all parents or legal guardians, and verbal assent was secured from participating children. Participants were informed of their right to withdraw from the study at any time without penalty. All data were collected and stored by institutional data protection protocols.

III. RESULTS

This study was conducted in January 2024 at Raden Paku Kindergarten, a private educational institution located at Klampis Ngasem 88a, Sukolilo, Surabaya. The research aimed to evaluate the efficacy of the TURBODENT (Try Using Box Dental) intervention in enhancing toothbrushing skills among preschool children. A total of 40 children, aged five to six years, were recruited from Raden Paku Kindergarten and randomly assigned to either an intervention group or a control group, with each group comprising 20 participants. Demographic analysis (TABLE 1) revealed that the majority of participants were six years old (77.5%), with a gender distribution of 55% male and 45% female. Before the intervention, an assessment of toothbrushing skills revealed that all children (100%) in the intervention group demonstrated suboptimal brushing proficiency (TABLE 2). Similarly, in the control group, 19 out of 20 children (95%) exhibited comparable low skill levels. This establishes a clear baseline of limited brushing competency across both groups before the introduction of the TURBODENT media.

TABLE 1
Frequency Distribution Based on Age and Gender in Raden Paku Surabaya Kindergarten in 2024

Category		Group					
		Intervention		Control		Sum	
		f	%	f	%	f	%
Age	5 years	4	20	5	20	9	22.5
	6 years	16	80	15	80	31	77.5
Gender	Male	10	50	12	70	22	55
	Female	10	50	8	30	18	45

TABLE 2
Frequency Distribution of Tooth Brushing Skills in Children Aged 5-6 Years Before Being Educated with TURBODENT Media at Raden Paku Kindergarten Surabaya in 2024

Categories Brushing Skills	Intervention Group		Control Group	
	f	%	f	%
Good	0	0	0	0
Moderate	0	0	1	5
Poor	20	100	19	95
Total	20	100	20	100

TABLE 3
Frequency Distribution of Brushing Skills in Children Aged 5-6 Years After Being Educated with TURBODENT Media at Raden Paku Kindergarten Surabaya in 2024

Categories Brushing Skills	Intervention Group		Control Group	
	f	%	f	%
Good	16	80	0	0
Adequate	14	20	1	5
Poor	0	0	19	95
Total	20	100	20	100

Following the educational intervention utilizing the TURBODENT media, a notable improvement in brushing skills was observed within the intervention group (TABLE 3). Specifically, 16 out of 20 children (80%) in the intervention group achieved good brushing skills. In contrast, the control group showed no discernible change in brushing skill levels post-intervention. Statistical analysis of the pre- and post-test outcomes for the intervention group demonstrated a

significant impact of the TURBODENT media. As indicated by an asymptotic. Sig. (2-tailed) value of $0.000 < 0.05$ (TABLE 4), the null hypothesis (H_0) was rejected, and the alternative hypothesis (H_1) was accepted. This finding strongly suggests that the TURBODENT media serves as an effective tool for improving the brushing techniques of 5-6-year-old students at Raden Paku Kindergarten Surabaya. Conversely, the analysis of the control group's pre- and post-test brushing abilities revealed no statistically significant change.

TABLE 4

Wilcoxon Pre-test and Post-test Results of the Intervention Group at Raden Paku Kindergarten Surabaya in 2024

Variable	Category		
	Good	Enough	Poor
Pre-Test	0	0	20
Post-Test	16	4	0
P value	0.000		

TABLE 5

Wilcoxon Pre-test and Post-test Test Results of Control Group at Raden Paku Kindergarten Surabaya in 2024

Variable	Category		
	Good	Enough	Poor
Pre-Test	0	1	20
Post-Test	0	1	20
P value	1.000		

TABLE 6

Mann-Whitney Test Results on Post-test Scores of Intervention Group and Control Group in Raden Paku Kindergarten Surabaya in 2024

Variable	Category	
	Intervention	Control
Good	16	0
Moderate	4	1
Poor	0	19
P value	0.000	

With an Asympt. Sig. (2-tailed) value of $1.000 > 0.05$ (TABLE 5), the alternative hypothesis (H_1) was rejected, and the null hypothesis (H_0) was supported. This confirms that, in the absence of the TURBODENT intervention, no improvement in brushing skills occurred within the control group. A comparative analysis of post-test brushing abilities between the intervention and control groups yielded a p-value of $0.000 < 0.05$ (TABLE 6). This significant result led to the acceptance of the alternative hypothesis (H_1) and the rejection of the null hypothesis (H_0). Consequently, it can be concluded that the use of TURBODENT media significantly enhanced the brushing skills of the intervention group when compared to the control group, which did not receive the intervention.

IV. DISCUSSION

The findings of this quasi-experimental study provide compelling evidence for the effectiveness of TURBODENT (Try Using Box Dental) interactive educational media in enhancing toothbrushing skills among preschool children aged 5-6 years. The baseline assessment revealed that the intervention group demonstrated uniformly inadequate toothbrushing competencies, while the control group exhibited predominantly inadequate skills with minimal variation. This initial homogeneity in skill deficits aligns with national epidemiological data indicating that only 1.4% of

children in this age cohort possess adequate toothbrushing proficiency, underscoring the widespread nature of this public health challenge [28]. The observed pre-intervention behavioral patterns, characterized by predominantly vertical or horizontal brushing movements with systematic neglect of lingual surfaces and tongue cleaning, reflect typical developmental limitations in motor coordination and spatial awareness characteristic of preschool populations. These findings corroborate the theoretical framework proposed by Gestina and Meilita, who established a significant correlation between comprehensive dental health knowledge and adoption of appropriate oral hygiene behaviors [29]. The absence of adequate parental supervision and guidance identified in this study further supports the multifactorial etiology of inadequate toothbrushing skills, encompassing both knowledge deficits and environmental factors.

Post-intervention analysis revealed statistically significant improvements in the intervention group, with the majority of participants achieving proficient toothbrushing skill classifications. This transformation can be attributed to the interactive design elements of the TURBODENT media, which incorporated gamification principles through card-based learning sequences, vibrant visual stimuli, and tactile manipulation activities. The media's effectiveness appears to stem from its alignment with developmentally appropriate learning modalities, specifically capitalizing on preschoolers' natural affinity for play-based educational experiences [30]. These findings demonstrate remarkable consistency with previous investigations examining game-based educational interventions for oral health promotion. Notably, Ningsih et al. documented similar efficacy of smart card game models in enhancing toothbrushing competencies and reducing dental plaque accumulation among pediatric populations [31]. The convergence of these results suggests that interactive card-based educational media represents a promising modality for addressing oral health skill deficits in early childhood settings. The theoretical underpinnings of these outcomes can be explained through Skinner's Stimulus-Organism-Response (S-O-R) behavioral modification framework, wherein the TURBODENT media functioned as an environmental stimulus capable of eliciting measurable behavioral responses. The multi-sensory engagement facilitated by the interactive card sequencing activities, combined with practical demonstration opportunities using dental phantoms and miniature toothbrushes, appears to have enhanced both cognitive processing and motor skill acquisition [32].

Conversely, the control group demonstrated no significant improvement in toothbrushing proficiency following conventional educational approaches, maintaining baseline inadequacy levels throughout the study period. This stagnation aligns with findings reported by Wicaksono et al., who identified the inherent limitations of traditional didactic instruction in establishing sustainable oral hygiene behaviors among school-age children [33]. The absence of engaging, interactive elements in conventional approaches may fail to capture and maintain the attention spans characteristic of preschool learners, thereby limiting knowledge retention and skill transfer. Several limitations warrant consideration in the interpretation of these findings. The purposive sampling

methodology, while appropriate for the research objectives, may limit the generalizability of results to broader preschool populations with different demographic characteristics, socioeconomic backgrounds, or cultural contexts. The single-institution setting further restricts external validity, as institutional-specific factors such as existing health education programs, facility resources, and staff expertise may have influenced outcomes. The 21-day intervention period, while theoretically grounded in behavioral change literature, represents a relatively brief timeframe for establishing sustained behavioral modifications. Long-term follow-up assessments would provide valuable insights into the durability of skill improvements and the potential for behavioral decay over extended periods. Additionally, the absence of objective plaque assessment measures limits the evaluation of clinical effectiveness, focusing exclusively on behavioral competencies rather than measurable oral health outcomes. The study's reliance on observational assessment methods, despite employing validated instruments and establishing inter-rater reliability, introduces potential subjectivity in skill evaluation. While video recording facilitated verification procedures, the artificial nature of demonstration-based assessments may not fully capture natural toothbrushing behaviors exhibited in home environments without supervision. The quasi-experimental design, while appropriate for educational intervention research, lacks the methodological rigor of randomized controlled trials. The absence of participant and assessor blinding, although challenging to implement in educational interventions, may have introduced performance and detection bias. Furthermore, the small sample size, while statistically adequate for detecting medium to large effect sizes, may have limited power to identify subtle differences or subgroup variations. Environmental factors beyond the scope of this investigation, including parental reinforcement, home oral hygiene practices, and concurrent health education exposures, may have influenced outcomes. The study did not control for these potential confounding variables, which could have contributed to observed between-group differences [34].

The demonstrated effectiveness of TURBODENT interactive educational media carries significant implications for pediatric oral health promotion strategies and early childhood educational curricula. The integration of gamification principles with health education content represents a scalable approach for addressing widespread oral hygiene skill deficits in preschool populations. Educational institutions and healthcare organizations should consider adopting similar interactive media platforms as standard components of comprehensive oral health promotion programs. The findings support the theoretical foundations of constructivist learning theory, suggesting that hands-on, experiential learning approaches may be superior to passive instructional methods for complex skill acquisition in early childhood. This has broader implications for health education pedagogy, indicating that interactive, multi-sensory educational interventions may enhance learning outcomes across various health behavior domains [35]. From a public health perspective, the cost-effectiveness and scalability of interactive educational media present attractive alternatives to resource-intensive individual instruction methods. The standardized nature of media-based interventions may

facilitate consistent implementation across diverse settings while maintaining educational quality and fidelity. Healthcare policy makers should consider supporting the development and dissemination of evidence-based educational media for preventive health interventions. Future research should address the identified limitations through longitudinal study designs incorporating extended follow-up periods to assess behavioral maintenance and clinical outcomes. Multi-site studies with diverse populations would enhance external validity and inform adaptation strategies for different cultural contexts. Additionally, economic evaluation studies examining cost-effectiveness compared to traditional educational approaches would provide valuable information for resource allocation decisions. Investigations comparing different interactive media formats, including digital applications, augmented reality platforms, and traditional tactile materials, would inform optimal design strategies for educational interventions. Furthermore, research examining the role of parental involvement and home environment factors in mediating intervention effectiveness would contribute to a comprehensive understanding of behavioral change mechanisms [36]. The development of standardized, validated assessment tools for evaluating toothbrushing skills in preschool populations remains a priority for advancing research in this field. Incorporation of objective measures, such as plaque reduction indices and long-term oral health outcomes, would strengthen the evidence base for interactive educational interventions and support their integration into routine preventive care protocols.

V. CONCLUSION

This quasi-experimental investigation aimed to evaluate the effectiveness of TURBODENT (Try Using Box Dental) interactive educational media on the development of toothbrushing skills among preschool children aged 5-6 years at Raden Paku Kindergarten in Surabaya. The study's findings provide compelling evidence for the intervention's efficacy in addressing fundamental oral hygiene competency deficits in early childhood populations. Baseline assessment revealed that all participants in the intervention group ($n=20$) demonstrated inadequate toothbrushing skills, while the control group exhibited predominantly inadequate performance with minimal variation. Following the 21-day structured intervention protocol, statistical analysis using the Wilcoxon signed-rank test demonstrated significant improvement in the intervention group ($p = 0.000$), with the majority of participants achieving proficient skill classifications. Conversely, the control group maintained baseline inadequacy levels throughout the study period ($p = 1.000$), indicating no measurable improvement with conventional educational approaches. Between-group analysis using the Mann-Whitney U test revealed statistically significant differences favoring the intervention group ($p = 0.000$), confirming the superior effectiveness of interactive educational media compared to traditional instructional methods. These quantitative findings substantiate the theoretical framework that gamification principles and multi-sensory learning modalities enhance skill acquisition and behavioral modification in preschool populations. The TURBODENT media's integration of card-based sequencing activities, visual stimuli, and tactile manipulation components

appears to have successfully addressed the developmental learning preferences characteristic of 5-6-year-old children. Future research endeavors should prioritize longitudinal investigations to assess the sustainability of behavioral improvements and their translation into measurable oral health outcomes over extended timeframes. Additionally, multi-site studies incorporating diverse demographic populations would enhance external validity and inform scalability considerations for broader implementation. The development of comprehensive training programs for educators and parents represents a critical next step in maximizing intervention impact, as these stakeholders serve as primary reinforcement agents in children's daily oral hygiene routines. Furthermore, economic evaluation studies examining cost-effectiveness compared to traditional educational approaches would provide valuable insights for healthcare policy development and resource allocation decisions. The integration of objective plaque assessment measures and clinical oral health indicators in future studies would strengthen the evidence base for interactive educational interventions and support their incorporation into routine preventive care protocols.

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DATA AVAILABILITY

No datasets were generated or analyzed during the current study.

AUTHOR CONTRIBUTION

Azzahra Septiana Nur Annisa served as the principal investigator, conceptualizing the research framework, designing the TURBODENT educational media intervention, conducting data collection procedures, and preparing the initial manuscript draft. Bambang Hadi Sugito provided methodological expertise, supervised the quasi-experimental design implementation, contributed to statistical analysis interpretation, and participated in manuscript revision processes. Ida Chairanna Mahirawatie facilitated institutional coordination with Raden Paku Kindergarten, oversaw ethical compliance procedures, assisted in participant recruitment and data collection activities, and contributed to the discussion section development. Isnanto provided technical guidance for the interactive educational media development, supervised the

intervention protocol implementation, contributed to data analysis procedures, and participated in manuscript review and finalization. All authors collaboratively contributed to the study's conceptualization, critically reviewed the manuscript content, and approved the final version for publication.

DECLARATIONS

ETHICAL APPROVAL

Ethical approval is not available.

CONSENT FOR PUBLICATION PARTICIPANTS

Written informed consent for publication of study findings was obtained from all participants' parents or legal guardians prior to data collection. All participants provided verbal assent for their involvement in the research activities and subsequent publication of anonymized results.

COMPETING INTERESTS

The authors declare no financial, personal, or professional conflicts of interest that could potentially influence the conduct, interpretation, or reporting of this research investigation.

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