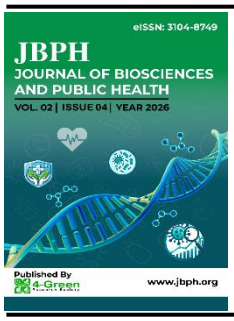

J. Biosci. Public Health 2026; 2(4):313-326

Journal of Biosciences and Public Health

Open access

DOI: https://doi.org/10.5455/JBPH.2026.15

Published by: 4-Green Research Society

Original Article

Effectiveness of a Mobile Health Intervention Combining Oral Health Education and Daily Monitoring to Improve Parental Knowledge and Toothbrushing Skills in Children with Intellectual Disabilities

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Article information
Received: July 03, 2026
Accepted: July 31, 2026
Published: August 13, 2026
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Keywords: ***Android application; children with intellectual disabilities; oral health education; parental knowledge; toothbrushing skills***

Cite this article:
Rusmiati, H. Boy, S. Riyadi. Effectiveness of a Mobile Health Intervention Combining Oral Health Education and Daily Monitoring to Improve Parental Knowledge and Toothbrushing Skills in Children with Intellectual Disabilities. J. Biosci. Public Health. 2026;2(4):313-326. doi:10.5455/JBPH.2026.15

ABSTRACT

Children with intellectual disabilities require continuous parental assistance to maintain proper oral hygiene because of their cognitive and adaptive limitations. However, educational approaches that combine oral health education with behavioral monitoring remain limited. This study aimed to evaluate the effectiveness of an Android-based Toothbrushing Monitoring Calendar application in improving parents' toothbrushing knowledge and children's toothbrushing skills. A quasi-experimental study using a nonequivalent control group pretest–posttest design was conducted among 80 parent–child pairs, consisting of 40 participants in the intervention group and 40 participants in the control group. The intervention group received oral health educational materials, reminder notifications, and daily monitoring for four weeks, whereas the control group received conventional oral health education. Data were analyzed using paired-samples *t*-test, independent-samples *t*-test, and Cohen's *d* with a significance level of 0.05. Parents' knowledge scores in the intervention group increased from 8.95 ± 1.280 to 11.93 ± 0.267 ($p < 0.001$), whereas the control group improved from 8.40 ± 1.630 to 9.13 ± 1.305 ($p < 0.001$). Children's toothbrushing skills increased from 5.00 ± 1.410 to 11.50 ± 1.080 in the intervention group, while the control group showed only a slight improvement from 5.63 ± 1.520 to 5.95 ± 1.430. The improvements in parents' knowledge ($\Delta = 2.98$ vs 0.73; $p < 0.001$) and children's toothbrushing skills ($\Delta = 6.50$ vs 0.32; $p < 0.001$) were significantly greater in the intervention group than in the control group. The intervention also demonstrated large effect sizes for parents' knowledge (Cohen's $d = 2.27$) and children's toothbrushing skills (Cohen's $d = 3.82$). These findings indicate that the Android-based Toothbrushing Monitoring Calendar application is an effective digital oral health education tool for improving parental knowledge and enhancing toothbrushing skills among children with intellectual disabilities through continuous education, and parental monitoring.

1. INTRODUCTION

Oral health is an essential component of overall health and contributes to growth, nutritional status, speech development, and quality of life [1]. Brushing teeth correctly at least twice a day with fluoride toothpaste is one of the simplest and most effective measures to prevent dental plaque, dental caries, and periodontal diseases. However, establishing regular toothbrushing habits depends not only on individual knowledge but also on family support, early habit formation, and educational strategies that encourage long-term behavioral change [2]. This issue is particularly important for children with intellectual disabilities, who have limitations in intellectual functioning and adaptive skills that require continuous assistance in performing daily self-care activities. Consequently, parents play a central role in guiding, supervising, and reinforcing appropriate toothbrushing practices [3].

Oral diseases remain a major public health problem worldwide. The World Health Organization (WHO) estimates that oral diseases affect approximately 3.5 billion people globally, while more than 514 million children suffer from dental caries in primary teeth [4]. In Indonesia, the Indonesian Health Survey (SKI) reported a high prevalence of oral health problems, whereas the proportion of individuals who brush their teeth at the recommended times, namely after breakfast and before bedtime, remains relatively low [5]. These findings indicate that adequate knowledge does not always translate into appropriate oral hygiene practices, particularly among children who require intensive parental assistance [6]. Several factors may contribute to this condition, including limited parental knowledge, children's cognitive and motor limitations, lack of engaging educational media, and the absence of a structured system for monitoring daily toothbrushing practices at home. These challenges highlight the need for educational approaches that not only improve parental knowledge but also facilitate continuous supervision and habit formation [7].

Previous systematic reviews have demonstrated that digital oral health education, mobile health (mHealth), and caregiver-supported behavioral interventions can improve parental oral health knowledge, children’s toothbrushing behavior, and long-term oral hygiene maintenance [8, 9]. However, most digital oral health interventions primarily deliver educational content without integrating continuous behavioral monitoring, automated reminders, and parental supervision into a single platform. Furthermore, very few applications have been specifically developed for parents of children with intellectual disabilities [10-12]. For this population, successful behavior development largely depends on active parental involvement, repetitive instruction, and structured routines.

Unlike previous mHealth interventions that focused mainly on education or teleconsultation, the Android-based Toothbrushing Monitoring Calendar application integrates three evidence-based behavioral components within a single platform: oral health education, automated reminder notifications, and structured daily monitoring by parents. This integrated approach is specifically designed to support parents of children with intellectual disabilities and addresses a key limitation identified in earlier digital oral health interventions.

Therefore, this study aimed to evaluate the effectiveness of the Android-based Toothbrushing Monitoring Calendar application in improving parents’ toothbrushing knowledge and children’s toothbrushing skills. The findings are expected to provide evidence supporting the use of digital oral health education as a practical strategy for healthcare professionals, teachers, and families to improve oral hygiene practices among children with intellectual disabilities.

2. METHODOLOGY

2.1. Study design

This study employed a quantitative quasi-experimental design using a nonequivalent control group pretest–posttest approach to evaluate the effectiveness of a mobile health (mHealth) intervention for improving parental oral health knowledge and toothbrushing skills among children with intellectual disabilities. Participants were assigned to either an intervention group or a control group without individual randomization. Both groups completed baseline (pretest) and post-intervention (posttest) assessments. The intervention group received oral health education through the Android-based Toothbrushing Monitoring Calendar application, whereas the control group received conventional oral health education. This design was selected because random allocation was not feasible within the school setting. So, participants were assigned according to their existing class distribution. Baseline characteristics and outcome measures were assessed before the intervention to evaluate the comparability of the two groups. Outcomes were reassessed immediately after the intervention and at a two-week follow-up to examine short-term maintenance of intervention effects.

2.2. Study setting and participants

The study was conducted at SLBN Prof. Sri Soedewi Maschun Sofuan, Jambi City, Indonesia, from March to May 2026. This public special education school provides educational services for children with intellectual disabilities. The intervention lasted four consecutive weeks, during which participants in the intervention group used the Android-based Toothbrushing Monitoring Calendar application daily.

Eligible participants were parents or primary caregivers of children aged 7–15 years with mild intellectual disabilities who owned an Android smartphone and provided written informed consent. Children with moderate or severe intellectual disabilities, physical conditions that prevented independent toothbrushing, or parents unable to operate an Android smartphone were excluded. Participants who withdrew from the study, failed to complete the post-intervention assessment, or discontinued application use for more than three consecutive days were considered dropouts.

2.3. Sample size determination

The minimum sample size was calculated using G*Power version 3.1.9.7 for comparison of two independent means with an effect size of 0.80, statistical power of 80%, a significance level of 0.05, and an allocation ratio of 1:1. The calculation indicated a minimum of 72 participants (36 per group). After allowing for a 10% attrition rate, the final sample consisted of 80 parent–child pairs, with 40 participants allocated to each group.

2.4. Sampling and group allocation

Participants were recruited using purposive sampling based on the predefined eligibility criteria. Eligible parents were identified through school records and confirmed by classroom teachers. To minimize disruption to school activities and reduce contamination, participants were assigned according to their existing class distribution, resulting in 40 parent–child

pairs in both the intervention and control groups. Baseline demographic characteristics and outcome measures were compared to ensure that the groups were comparable before the intervention.

2.5. Intervention

Mobile health intervention: The intervention consisted of an Android-based Toothbrushing Monitoring Calendar application designed to provide continuous oral health education, automated reminders, and structured daily monitoring of children's toothbrushing activities.

The educational component included information on the importance of oral hygiene, recommended toothbrushing frequency and timing, appropriate toothbrushing techniques, selection of toothbrushes and fluoride toothpaste, and guidance for parents on assisting children with intellectual disabilities. Educational materials were presented using simplified text and illustrations.

The application generated automated reminders twice daily, after breakfast and before bedtime. Parents were instructed to respond to the reminders and record their child's toothbrushing activity using the application's monitoring calendar. Participants used the application daily for four consecutive weeks.

Before implementation, trained dental health educators provided standardized instructions on application installation and use. Application activity records were used to monitor engagement. Parents who failed to record toothbrushing activities for more than three consecutive days were contacted by telephone as a reminder to resume application use.

Control condition: Participants in the control group received a single face-to-face oral health education session using lectures, discussions, and printed educational leaflets covering the same oral health topics. The control group did not receive access to the mobile application, automated reminders, or digital monitoring during the intervention period.

2.6. Outcome measures and instruments

The primary outcome was parents' knowledge regarding toothbrushing, measured using a structured questionnaire consisting of 15 multiple-choice questions developed according to the Indonesian Ministry of Health oral health education guidelines. Each correct response received one point, yielding a total score ranging from 0 to 15, with higher scores indicating better knowledge.

The secondary outcome was children's toothbrushing skills, assessed using a standardized observational checklist evaluating brushing sequence, brushing technique, tooth surface coverage, brushing duration, toothbrush handling, and overall performance. Scores ranged from 0 to 12, with higher scores representing better toothbrushing skills.

2.7. Validity and reliability procedures

Both instruments were reviewed by three experts in dental public health and special needs education. A pilot study involving 20 parents demonstrated acceptable validity (item-total correlation >0.30) and good internal consistency, with Cronbach's alpha values of 0.86 for the knowledge questionnaire and 0.89 for the observational checklist.

Children's toothbrushing skills were independently assessed by two dental health educators with more than five years of experience in community oral health programs. Before data collection, both observers completed standardized training on the use of the observational checklist, including calibration sessions using recorded toothbrushing demonstrations to ensure consistent scoring criteria. The observers were blinded to participants' group allocation and previous assessment results during both baseline and post-intervention evaluations. Inter-rater reliability was assessed in a pilot evaluation involving 20 parent–child pairs, yielding an intraclass correlation coefficient (ICC) of 0.91, indicating excellent agreement between observers.

2.8. Study procedures

Following approval from the school administration, eligible parents were invited to participate and provided written informed consent. Baseline demographic information was collected, followed by administration of the knowledge questionnaire and assessment of children's toothbrushing skills.

Parents in the intervention group attended a brief orientation session on installing and using the Android application before beginning the 4-week intervention. They were instructed to review the educational materials, respond to reminder notifications, and record their children's toothbrushing activities daily throughout the four-week intervention period. Participants in the control group attended a conventional oral health education session using standardized teaching materials.

Posttest assessments were conducted immediately after completion of the four-week intervention using the same questionnaire and observational checklist administered at baseline. Because the primary objective of the present study was to evaluate the immediate effectiveness of the intervention, no additional follow-up assessment was included in the final analysis.

2.9. Statistical analysis

Data were analyzed using IBM SPSS Statistics version 27.0 (IBM Corp., Armonk, NY, USA). Continuous variables are presented as mean ± standard deviation (SD), while categorical variables are summarized using frequencies and percentages. Data normality and homogeneity of variance were evaluated using the Shapiro–Wilk and Levene's tests, respectively. Baseline demographic characteristics and baseline outcome variables (parents' toothbrushing knowledge scores and children's toothbrushing skill scores) were compared between groups using independent-samples t-tests for continuous variables and chi-square tests for categorical variables to confirm baseline equivalence prior to the intervention. Changes in parental knowledge and children's toothbrushing skills were initially examined within each study group. Between-group differences in post-intervention outcomes were assessed using analysis of covariance (ANCOVA), with baseline outcome scores included as covariates to account for baseline differences and improve the precision of intervention-effect estimates. Mean changes from baseline were also compared between the intervention and control groups. Effect sizes were estimated using Cohen's d, with values of 0.20, 0.50, and 0.80 interpreted as small, medium, and large effects, respectively [13]. For the two-week follow-up assessment, outcome scores were compared between the intervention and control groups to evaluate

the persistence of intervention effects. All statistical tests were two-sided, and statistical significance was set at $p < 0.05$. Effect estimates were reported with 95% confidence intervals where applicable.

3. RESULTS

3.1. Participant characteristics and baseline comparability

A total of 80 parent–child pairs were included in the study, with 40 assigned to the intervention group and 40 to the control group. The groups were comparable at baseline with respect to parental age, sex, educational level, occupation, children's age, and sex (all $p > 0.05$) (**Table 1**).

Table 1. Baseline characteristics of parent–child pairs by study group.

Characteristics	Intervention (n = 40), n (%)	Control (n = 40), n (%)	p-value
Parents' age (years)			**0.718**
20–30	8 (20.0)	9 (22.5)	
31–40	20 (50.0)	18 (45.0)	
>40	12 (30.0)	13 (32.5)	
Parents' sex			**0.754**
Male	7 (17.5)	8 (20.0)	
Female	33 (82.5)	32 (80.0)	
Educational level			**0.662**
Primary school	4 (10.0)	5 (12.5)	
Junior high school	11 (27.5)	12 (30.0)	
Senior high school	18 (45.0)	17 (42.5)	
College/University	7 (17.5)	6 (15.0)	
Occupation			**0.603**
Homemaker	22 (55.0)	23 (57.5)	
Private employee	8 (20.0)	7 (17.5)	
Self-employed	6 (15.0)	6 (15.0)	
Civil servant	4 (10.0)	4 (10.0)	
Children's age (years)			**0.835**
7–9	13 (32.5)	14 (35.0)	
10–12	17 (42.5)	16 (40.0)	
13–15	10 (25.0)	10 (25.0)	
Children's sex			**0.817**
Male	24 (60.0)	23 (57.5)	
Female	16 (40.0)	17 (42.5)	

Most parents were 31–40 years of age (50.0% in the intervention group and 45.0% in the control group), female (82.5% and 80.0%, respectively), and had completed senior high school (45.0% and 42.5%, respectively). More than half of the parents

in both groups were homemakers (55.0% and 57.5%). Among the children, the largest age group was 10–12 years (42.5% in the intervention group and 40.0% in the control group), and approximately three-fifths were male (60.0% and 57.5%, respectively).

3.2. Effects of the mobile health intervention on parental knowledge and children's toothbrushing skills

Table 2 presents the pre- and post-intervention scores for both outcomes within each group. The intervention group demonstrated substantial improvements in both parental toothbrushing knowledge and children's toothbrushing skills following the four-week mobile health intervention. In the intervention group, parents' mean knowledge score increased significantly from 8.95 ± 1.280 to 11.93 ± 0.267 (mean difference = 2.98, 95% CI: 2.54–3.42; $p < 0.001$). Children's toothbrushing skill scores also improved markedly, rising from 5.00 ± 1.410 to 11.50 ± 1.080 (mean difference = 6.50, 95% CI: 5.86–7.14; $p < 0.001$). These findings suggest that the Android-based Toothbrushing Monitoring Calendar application substantially enhanced children's toothbrushing skills through active parental involvement.

In the control group, parents' knowledge showed a smaller and statistically significant increase from 8.40 ± 1.630 to 9.13 ± 1.305 (mean difference = 0.73, 95% CI: 0.32–1.14; $p < 0.001$). However, the change in children's toothbrushing skills was minimal and did not reach statistical significance (5.63 ± 1.520 to 5.95 ± 1.430; mean difference = 0.32, 95% CI: −0.01–0.65; $p = 0.051$). However, the paired-samples *t*-test indicated that this improvement was not statistically significant ($p = 0.051$). Therefore, conventional education alone did not produce a significant improvement in the toothbrushing skills of children with intellectual disabilities.

The overall distribution pattern suggests the possibility of a ceiling effect, whereby many participants achieved similarly high scores following the intervention (SD = 0.267). Although this finding reflects a high level of knowledge acquisition, it may also have reduced the instrument's ability to discriminate among participants with very high levels of knowledge after the intervention.

Table 2. Within-group comparison of parents' knowledge and children's toothbrushing skills before and after the intervention.

Group and Outcome	Pretest Mean ± SD	Posttest Mean ± SD	Mean Difference (95% CI)	p-value*
Intervention group (n = 40)				
Parents' knowledge	8.95 ± 1.280	11.93 ± 0.267	2.98 (2.54–3.42)	<0.001
Children's toothbrushing skills	5.00 ± 1.410	11.50 ± 1.080	6.50 (5.86–7.14)	<0.001
Control group (n = 40)				
Parents' knowledge	8.40 ± 1.630	9.13 ± 1.305	0.73 (0.32–1.14)	<0.001
Children's toothbrushing skills	5.63 ± 1.520	5.95 ± 1.430	0.32 (−0.01–0.65)	0.051

**Paired-samples t-test.*

3.3. Between-group comparison of change scores

According to **Table 3**, comparison of the change scores (Δ scores) between groups demonstrated that the improvement in parental toothbrushing knowledge was significantly greater in the intervention group (2.98 ± 1.12) than in the control group (0.73 ± 1.05), with a mean difference of 2.25 points (95% CI: 1.76–2.74; $p < 0.001$). Likewise, the improvement in children's toothbrushing skills was substantially greater in the intervention group (6.50 ± 1.63) compared with the control group (0.32 ± 1.48), yielding a mean difference of 6.18 points (95% CI: 5.49–6.87; $p < 0.001$). These findings demonstrate that the Android-based Toothbrushing Monitoring Calendar application was significantly more effective than conventional oral health education in improving both parental knowledge and children's toothbrushing skills.

Table 3. Comparison of change scores (Δ) between the intervention and control groups.

Outcome	Intervention Mean ± SD	Control Mean ± SD	Mean Difference (95% CI)	p-value*
Δ Parents' knowledge	2.98 ± 1.12	0.73 ± 1.05	2.25 (1.76–2.74)	<0.001
Δ Children's toothbrushing skills	6.50 ± 1.63	0.32 ± 1.48	6.18 (5.49–6.87)	<0.001

**Independent-samples t-test.*

3.4. Effect size

Effect size analysis demonstrated (**Table 4**) that the Android-based Toothbrushing Monitoring Calendar application produced a very large effect on both parental toothbrushing knowledge (Cohen's $d = 2.27$, 95% CI: 1.67–2.87) and children's toothbrushing skills (Cohen's $d = 3.82$, 95% CI: 3.01–4.63). According to Cohen's classification, both effect sizes exceeded the threshold for a large effect ($d \geq 0.80$), indicating that the intervention was not only statistically significant but also had substantial practical significance in improving oral health knowledge among parents and toothbrushing skills among children with intellectual disabilities.

Table 4. Effect sizes (Cohen's d) of the intervention.

Outcome	Cohen's d	95% CI	Interpretation
Parents' toothbrushing knowledge	2.27	1.67–2.87	Large effect
Children's toothbrushing skills	3.82	3.01–4.63	Large effect

Overall, the intervention group consistently outperformed the control group across both primary outcomes. Compared with conventional oral health education, the Android-based Toothbrushing Monitoring Calendar application produced significantly greater improvements in parental toothbrushing knowledge and children's

toothbrushing skills, with very large effect sizes (Cohen's d = 2.27 and 3.82, respectively). These findings provide strong evidence that integrating oral health education with reminder notifications and structured daily monitoring offers substantial advantages over conventional educational approaches.

3.5. Follow-up assessment

As shown in Table 5, two weeks after completion of the intervention, participants in the intervention group maintained substantially higher knowledge and toothbrushing skill scores than those in the control group. Although a slight decline in mean scores was observed compared with the immediate posttest, both outcomes remained significantly higher than baseline values, indicating that the beneficial effects of the Android-based Toothbrushing Monitoring Calendar application were sustained during the short-term follow-up period.

Table 5. Two-week follow-up assessment.

Outcome	Intervention	Control	p-value
Knowledge	11.80 ±0.45	9.05 ±1.22	<0.001
Toothbrushing skill	11.20 ±1.18	5.90 ±1.44	<0.001

4. DISCUSSION

The findings of this study demonstrate that the Android-based Toothbrushing Monitoring Calendar application effectively improved parents' knowledge of proper toothbrushing and children's toothbrushing skills. Parents who received the application showed significantly greater improvements in knowledge than those who received conventional oral health education. Similarly, children in the intervention group experienced marked improvements in toothbrushing skills, whereas only minimal changes were observed in the control group. These findings indicate that combining oral health education with reminder notifications and daily monitoring is more effective than conventional one-time educational sessions. The large effect sizes further suggest that the intervention has not only statistical significance but also meaningful practical value, supporting the use of digital applications as an educational strategy for parents of children with intellectual disabilities [14,15].

The present findings are consistent with previous studies highlighting the benefits of mobile health (mHealth) interventions for oral health promotion [16]. A systematic review by Wang et al. [17]. reported that mHealth-based education significantly improved parents' oral health knowledge and increased their involvement in children's oral health care compared with traditional educational approaches. Likewise, Aliakbar et al. [18] concluded that caregiver education and supervised toothbrushing are effective in improving oral hygiene among children with intellectual disabilities. In addition, Alholimie et al. [19] reported that preventive oral health programs for children with special needs are most effective when they integrate caregiver involvement, structured oral health education, and continuous behavioral support. Similarly, Lai et al. [20]

demonstrated that oral health education and promotion programs significantly improve oral hygiene outcomes among children with special needs. Together, these findings support the importance of parent-centered educational strategies in promoting sustainable toothbrushing behaviors.

Several factors may explain why the intervention produced better outcomes than conventional education. Unlike traditional educational sessions, which are usually conducted only once, the Android application provided continuous access to educational materials, automatic reminders, and daily monitoring of toothbrushing activities [21]. Repeated exposure to health information helps strengthen knowledge retention and encourages parents to consistently supervise their children's oral hygiene practices. In addition, the monitoring feature promoted active parental participation rather than passive receipt of health information. This continuous engagement likely increased parents' motivation and responsibility to ensure that children brushed their teeth regularly. Such an approach is particularly important for children with intellectual disabilities because they generally require repetitive instruction, structured routines, and continuous caregiver assistance due to limitations in cognitive functioning, memory, and adaptive behavior [14,15].

The findings can also be explained using the Health Belief Model (HBM) and Social Cognitive Theory (SCT). According to the HBM, health behaviors are influenced by perceived benefits, perceived barriers, self-efficacy, and cues to action. In this study, the application served as both an educational resource and a continuous cue to action through reminder notifications and monitoring features [22, 23]. These components likely increased parents' awareness of the importance of supervising toothbrushing while improving their confidence in assisting their children. Social Cognitive Theory further explains that behavioral change occurs through the interaction of knowledge, environmental support, repeated practice, and self-efficacy. By providing educational content alongside daily reminders and monitoring, the application created a supportive environment that encouraged parents to apply their knowledge consistently in everyday practice [24].

The present study also demonstrated a close relationship between parental knowledge and children's toothbrushing skills. Parents who understand appropriate toothbrushing techniques and oral hygiene recommendations are better able to supervise, motivate, and correct their children's brushing practices [17,18]. As parental knowledge increased following the intervention, children's toothbrushing skills improved simultaneously, suggesting that parents played a central role in facilitating behavioral change. This finding is consistent with previous studies showing that parental oral health knowledge is positively associated with children's oral hygiene practices and oral health outcomes [25]. Although causal relationships were not specifically examined, the parallel improvements observed in this study indicate that enhancing parental knowledge is an effective strategy for improving oral hygiene behaviors among children with intellectual disabilities.

Although the observed improvements are encouraging, alternative explanations should also be considered when interpreting the findings. First, the Hawthorne effect may have contributed to the positive outcomes, as parents and children were aware that they were participating in a research study and that toothbrushing behaviors were being monitored. This awareness may have temporarily increased participants' motivation and adherence to recommended oral hygiene practices independent of the intervention itself. Second, the reliance on parent-reported monitoring records may have introduced social desirability bias, whereby parents may have overreported adherence to recommended toothbrushing routines in an effort to meet perceived expectations of the researchers. While daily monitoring was complemented by post-intervention observational

assessments of children's toothbrushing skills, these potential sources of bias cannot be completely excluded and should be considered when interpreting the magnitude of the intervention effect. Future studies should incorporate longer follow-up periods, objective clinical oral health indicators (e.g., plaque index and gingival index), and automated application log data to minimize these potential confounding mechanisms and strengthen the validity of the findings.

These findings have important implications for oral health promotion. The Android-based Toothbrushing Monitoring Calendar application offers an affordable and practical educational tool that can be implemented in special education schools, community health centers, and dental health programs. By combining educational materials, reminder notifications, and monitoring features, the application encourages active parental involvement and supports the development of consistent toothbrushing habits at home. This approach is particularly relevant for family-centered care, where parents play a crucial role in maintaining children's daily health behaviors. Digital applications may therefore complement conventional oral health education by providing continuous support beyond face-to-face educational sessions.

Despite these promising findings, several limitations should be considered. The study was conducted in a single special education school, which may limit the generalizability of the results to other populations. The intervention period was relatively short and therefore could not assess the long-term sustainability of behavioral changes. In addition, monitoring of children's toothbrushing practices relied partly on parental reporting, which may have introduced reporting bias. Furthermore, because participants were aware that they were being observed, the influence of the Hawthorne effect and social desirability bias cannot be entirely ruled out despite standardized study procedures. Future studies should include larger and more diverse populations, extend the follow-up period, and incorporate objective clinical indicators such as plaque index, gingival index, and dental caries incidence to further evaluate the long-term effectiveness of digital oral health interventions. Such evidence would strengthen the role of digital technology in promoting sustainable oral health behaviors among children with intellectual disabilities.

5. CONCLUSION

The findings of this study demonstrate that the Android-based Toothbrushing Monitoring Calendar application (mHealth) effectively improved parents' knowledge of proper toothbrushing practices and enhanced toothbrushing skills among children with intellectual disabilities. Compared with conventional oral health education, the application produced greater improvements by integrating educational materials, reminder notifications, and daily monitoring into a single digital platform. This integrated approach encouraged active parental involvement in supervising children's toothbrushing routines, thereby facilitating the development of more structured and sustainable oral health behaviors. Therefore, the Android-based application may be considered an effective oral health education tool to support the maintenance of oral hygiene among children with intellectual disabilities. The findings suggest that the Android-based Toothbrushing Monitoring Calendar application has the potential to be implemented as an educational and supportive tool in oral health promotion programs for children with intellectual disabilities. Special education schools, community health centers, oral health professionals, and parents may utilize this application to support oral health education and establish regular toothbrushing habits both at home and in school settings. Future studies are recommended to involve larger sample sizes, include more diverse study settings,

extend the duration of the intervention, and incorporate objective clinical oral health indicators, such as plaque index, gingival index, and dental caries incidence, to further evaluate the long-term effectiveness of the application.

ACKNOWLEDGMENTS

The authors would like to express their sincere gratitude to all parents and children with intellectual disabilities who participated in this study. The authors also extend their appreciation to the school principal, teachers, and all school staff for their valuable support throughout the implementation of the study. Finally, the authors gratefully acknowledge all members of the research team and everyone who contributed to the development of the application, data collection, and the successful completion of this research.

FUNDING STATEMENT

This research received no specific grant from any funding agency, commercial, or not-for-profit sectors.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest related to this manuscript.

ETHICAL CONSIDERATION

This study was conducted in accordance with the ethical approval from the Health Research Ethics Committee of Poltekkes Kemenkes Jambi, Indonesia, under Ethical Exemption No. LB.02.06/2/0062/2026. Written informed consent was obtained from all participating parents prior to data collection. Participation was entirely voluntary, and participants were informed of their right to withdraw from the study at any time without any consequences.

AUTHOR CONTRIBUTIONS

Rusmiati: Conceptualization, methodology, investigation, intervention implementation, data curation, formal analysis, writing original draft, and supervision. **Hendry Boy:** Methodology, investigation, data collection, validation, data curation, and writing review and editing. **Slamet Riyadi:** Methodology, investigation, data collection, validation, and writing review and editing. All authors have read and approved the final manuscript and agree to be accountable for all aspects of the work

DECLARATION OF AI USE

During the preparation of this manuscript, the authors used artificial intelligence (AI)-assisted language tools solely to improve grammar, language clarity, and readability. The AI tools were not used to generate scientific content, interpret data, draw conclusions. All literature selection, interpretation of the evidence, and final

manuscript preparation were prepared entirely by the authors, who accept full responsibility for the accuracy and integrity of the manuscript.

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