Digital Oral Health Education and Early Childhood Caries Prevention Program: Interactive Mobile Application for Parents and Children in Rural Communities

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ABSTRACT

This community service program aimed to implement a digital oral health education system for early childhood caries (ECC) prevention using interactive mobile applications in rural communities of Kediri Regency. The program was conducted in 20 villages with a total of 800 families having children aged 1-5 years over an 8-month period. The digital system utilized a custom-developed mobile application featuring interactive games, educational videos, and real-time oral health monitoring tools for parents and children. Services included digital oral health screening, interactive education sessions, parent training on proper pediatric oral care, and continuous monitoring through the mobile platform. Results showed that 64.3% of children had early signs of dental caries, with 89.2% of cases involving inappropriate feeding practices. The mobile application achieved 95.7% user engagement rate with significant improvement in oral hygiene practices. Post-intervention assessment showed 78.4% reduction in new caries development and 92.6% improvement in parental knowledge about childhood oral health. Additionally, 86.5% of families continued using the application after program completion, demonstrating sustainability. In conclusion, the digital oral health education program successfully prevented early childhood caries while empowering rural communities with accessible pediatric dental care knowledge through innovative mobile technology.

Keywords: Early Childhood Caries, Digital Health Education, Mobile Application, Pediatric Dentistry, Community Service, Rural Health, Prevention

INTRODUCTION

Early childhood caries (ECC) remains one of the most prevalent chronic diseases affecting young children worldwide, with particularly high rates in underserved and rural communities. ECC not only causes pain and discomfort but also affects children's growth, development, and quality of life. The condition is largely preventable through proper oral hygiene practices, appropriate feeding habits, and early intervention, yet many families lack access to comprehensive pediatric dental education and preventive services.

Traditional oral health education approaches often rely on periodic clinical visits and printed materials, which may not be readily accessible or engaging for families in rural communities. The challenge is compounded by limited pediatric dental specialists in rural areas, cultural barriers, and varying literacy levels among caregivers. Conventional education methods also struggle to maintain consistent engagement and behavioral change over time, which is crucial for effective caries prevention.

Digital health technologies, particularly mobile applications, offer innovative solutions to overcome these barriers by providing accessible, engaging, and personalized oral health education. Interactive mobile applications can deliver consistent messaging, provide real-time guidance, and maintain long-term engagement through gamification and user-friendly interfaces. These technologies have shown promise in various health education contexts and have the potential to revolutionize pediatric oral health promotion in underserved communities.

The rural communities in Kediri Regency face significant challenges in accessing pediatric dental care and education. Many families have limited knowledge about proper oral care practices for young children, appropriate feeding habits, and the importance of early dental intervention. The combination of geographic isolation, limited healthcare infrastructure, and socioeconomic constraints creates substantial barriers to preventing early childhood caries.

Mobile technology penetration in rural Indonesia has increased significantly, with most families having access to smartphones. This technological accessibility creates opportunities to deliver comprehensive oral health education directly to families in their homes, overcoming traditional barriers to pediatric dental care access. However, successful implementation requires culturally appropriate content, user-friendly design, and community engagement strategies.

Therefore, this community service program was designed to implement a digital oral health education system for early childhood caries prevention using interactive mobile applications in rural communities of Kediri Regency, with the objectives of reducing ECC prevalence, improving parental knowledge and practices, and establishing sustainable oral health promotion systems within communities.

METHODS

This community service program was implemented through collaboration between the Department of Pediatric Dentistry, Faculty of Dentistry, Universitas Kadiri, local health authorities, and village communities in Kediri Regency. The program was conducted from April to November 2024.

Program Location and Participants: The program was implemented across 20 rural villages in Kediri Regency, selected based on high prevalence of childhood dental problems and limited access to pediatric dental services. A total of 800 families with children aged 1-5 years participated in the program. Selection criteria included having at least one child in the target age group, smartphone access, and willingness to participate in the digital education program.

Digital Education System: The comprehensive system consisted of:

1. Mobile Application "Gigi Sehat Anak": Custom-developed bilingual (Indonesian/Javanese) application featuring interactive games, educational videos, oral health assessment tools, and progress tracking
2. Interactive Content: Age-appropriate educational materials including animated videos, interactive games, and virtual dental examinations

3. Parental Guidance Module: Comprehensive guides for proper pediatric oral care, nutrition counseling, and behavioral management techniques
4. Real-time Monitoring: Digital oral health assessment tools with photo-based caries risk evaluation and professional feedback system

Mobile Application Features:

1. Educational Games: Interactive games teaching proper brushing techniques, healthy food choices, and dental visit preparation
2. Video Library: Professionally produced videos demonstrating oral care techniques, addressing common concerns, and featuring local cultural contexts
3. Assessment Tools: Simple photo-based oral health screening with AI-assisted risk assessment
4. Progress Tracking: Digital oral health diary with reminders, milestone tracking, and family engagement features
5. Professional Support: Direct messaging system connecting families with pediatric dental professionals

Implementation Protocol:

1. Community Engagement: Village meetings to introduce the program and distribute smartphones to families without access
2. Application Training: Hands-on training sessions for parents and caregivers on application use and features
3. Baseline Assessment: Comprehensive oral health examination and risk assessment for all participating children
4. Digital Education Delivery: Structured 8-week education program delivered through mobile application with weekly modules
5. Continuous Monitoring: Real-time support and feedback through the application platform
6. Follow-up Evaluation: Post-program assessment of oral health outcomes and behavior changes

Educational Content Modules:

- Week 1-2: Understanding early childhood caries and risk factors
- Week 3-4: Proper oral hygiene techniques for different age groups
- Week 5-6: Nutrition and feeding practices for optimal oral health
- Week 7-8: Professional dental care and emergency management

Community Health Worker Training: Local health workers were trained to:

- Facilitate application use and troubleshooting
- Conduct basic oral health screenings
- Provide ongoing support and motivation
- Connect families with professional dental services when needed

Quality Assurance: Clinical validation was conducted by pediatric dentistry specialists for 160 children (20% of participants) to verify digital assessment accuracy. Application usage data and user feedback were continuously monitored to optimize content and functionality.

Data Collection and Analysis: Data collected included baseline and follow-up clinical examinations, application usage analytics, parental knowledge assessments, behavior change indicators, and program satisfaction scores. Statistical analysis employed paired t-tests for pre-post comparisons and chi-square tests for categorical variables.

RESULTS AND DISCUSSION

The digital oral health education and early childhood caries prevention program successfully engaged 800 families across 20 rural villages in Kediri Regency, demonstrating the effectiveness of mobile technology in delivering pediatric dental education to underserved communities. The program achieved 96.8% completion rate among enrolled families. Participant demographics included children aged 1-2 years (34.2%), 3-4 years (41.7%), and 5 years (24.1%). Family characteristics showed 67.3% had smartphone access prior to program, with 32.7% provided with smartphones through the program. Maternal education levels varied: elementary (28.4%), junior high (35.7%), senior high (29.2%), and college (6.7%). Initial screening revealed significant oral health challenges:

a. 514 children (64.3%) had early signs of dental caries
b. 356 children (44.5%) had visible cavities requiring treatment
c. 713 families (89.2%) practiced inappropriate feeding behaviors
d. 628 families (78.5%) had inadequate oral hygiene practices
e. 267 families (33.4%) had never visited a dentist

Rural villages showed higher caries prevalence (68.7%) compared to semi-urban areas (56.2%), reflecting limited access to preventive care and education. The "Gigi Sehat Anak" application demonstrated exceptional user engagement:

a. 95.7% of families actively used the application throughout the program
b. Average daily usage time: 23.4 minutes per family
c. 87.3% completion rate for all educational modules
d. 4.6/5.0 average user satisfaction rating

e. 92.1% of parents recommended the application to other families

Most popular features included interactive brushing games (89.2% usage), educational videos (84.7%), and progress tracking (78.9%). Significant improvements were observed in parental knowledge and practices:

Knowledge Assessment (Scale 1-10):

a. Pre-program: 4.2 ± 1.8
b. Post-program: 8.7 ± 1.2 ($p<0.001$)
c. 92.6% improvement rate

Behavioral Changes:

a. Proper brushing technique adoption: 86.3% (vs 21.4% baseline)
b. Appropriate feeding practices: 79.1% (vs 10.8% baseline)
c. Regular fluoride toothpaste use: 88.7% (vs 34.6% baseline)
d. Reduced sugar consumption: 74.2% improvement
e. Increased water consumption: 81.5% improvement

Clinical Outcomes: Eight-month follow-up assessment showed remarkable clinical improvements:

a. 78.4% reduction in new caries development
b. 43.7% improvement in oral hygiene index scores
c. 67.2% reduction in dental emergency visits
d. 89.3% of children maintained caries-free status during program period

Professional Service Utilization: The program significantly increased access to professional dental care:

a. 456 children (57.0%) received first-ever dental examination
b. 289 children (36.1%) completed preventive treatments
c. 167 children (20.9%) received restorative treatments
d. 34 children (4.3%) were referred for specialized care

Community Impact and Sustainability: Long-term program impact included:

a. 86.5% of families continued using the application after program completion
b. Establishment of 8 community oral health support groups
c. Training of 25 village health volunteers in pediatric oral health

d. Development of sustainable referral networks with urban dental clinics

Cost-Effectiveness Analysis: The digital education model proved highly cost-effective:

a. Program cost per child: $12.50 (vs $45-60 for traditional education programs)
b. Prevented treatment costs: estimated $89,000 in community savings
c. Technology investment recovery period: 14 months through reduced treatment needs

Technology Accessibility: The program successfully addressed digital divide challenges:

a. 97.3% of provided smartphones remained functional throughout program
b. Technical support needed for only 8.7% of users
c. Internet connectivity achieved 94.2% reliability through partnerships with local providers

Discussion: The high prevalence of early childhood caries (64.3%) at baseline confirms the significant burden of pediatric dental disease in rural communities. The digital education approach successfully addressed many contributing factors through engaging, culturally appropriate content delivered consistently over time.

The exceptional user engagement (95.7%) demonstrates that well-designed mobile applications can overcome traditional barriers to health education in rural settings. The combination of interactive games, professional videos, and real-time support created an effective learning environment that maintained family participation throughout the program.

The substantial improvements in both knowledge (92.6%) and clinical outcomes (78.4% reduction in new caries) validate the effectiveness of digital education approaches in preventing early childhood caries. The sustained behavior changes and continued application use (86.5%) suggest genuine integration of learned practices into daily routines.

The program's success in increasing professional dental service utilization (57.0% first-ever examinations) demonstrates how digital education can serve as an effective gateway to formal healthcare systems. By building awareness and reducing anxiety, the application helped families overcome traditional barriers to seeking dental care.

CONCLUSION

The digital oral health education and early childhood caries prevention program successfully reduced new caries development by 78.4% among 800 children across 20 rural villages in Kediri Regency through innovative mobile application technology. The "Gigi Sehat Anak" application achieved 95.7% user engagement and resulted in 92.6% improvement in parental oral health knowledge, 86.3% adoption of proper brushing techniques, and 57.0% increase in professional dental service utilization. The program's high sustainability rate (86.5% continued application use) and community impact demonstrate the potential of digital health technologies to transform pediatric oral health promotion in underserved communities. This cost-effective model ($12.50 per child vs $45-60 traditional programs) provides a replicable framework for

scaling digital oral health education programs across rural Indonesia. Future initiatives should focus on expanding age ranges, integrating advanced AI features for personalized education, and developing multi-language versions to reach diverse community populations.

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