


PROMOTING PRESCHOOL ORAL HEALTH IN SAFE COMMUNITIES: INNOVATIONS BRIDGING BRAIN DEVELOPMENT AND STROKE PREVENTION

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Info Article	Abstract
Article History: Received: 5 March 2025 Revised: 16 Apr 2025 Accepted: 21 Apr 2025 Available Online: 25 Apr 2025	<p>Preschool oral health is a critical component in supporting optimal growth and development, including physical, cognitive, and emotional aspects. However, the prevalence of oral health problems such as dental caries and periodontal disease remains high, particularly in communities with limited access to healthcare services. Research indicates that the explicit relationship between oral health, brain development, and stroke prevention has not been thoroughly explored. This study employs a narrative review method to analyze literature on preschool oral health, community-based innovations, and the Safe Community approach in chronic disease prevention. The findings reveal that good oral health supports brain development by improving nutritional intake and reducing systemic inflammation. The Safe Community approach, through multi-sectoral collaboration, community empowerment, and technological innovation, has proven effective in promoting preschool oral health. Moreover, oral health promotion contributes to stroke prevention by mitigating chronic inflammation associated with cardiovascular diseases. This review underscores the importance of integrating oral health programs into Safe Community-based policies and highlights the need for investment in technological innovation. The implications of this study include the development of community-based and technological interventions to improve preschool oral health, indirectly supporting brain health and preventing long-term chronic diseases.</p>
Keywords: Preschool oral health, Safe Community, brain development, stroke, community innovations	
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Introduction

The oral health of preschool children is a fundamental element in supporting optimal growth and development, including physical, cognitive, and emotional development. However, the prevalence of oral health issues such as dental caries and periodontal diseases remains high in this age group, especially in communities with limited access to healthcare services. This condition can significantly impact nutritional status, quality of life, and the child's learning abilities.(Stewart *et al.*, 2022)

Research shows that poor oral health in children can trigger systemic inflammation through the release of inflammatory mediators, which have long-term implications for the risk of chronic diseases such as stroke. On the other hand, good oral health supports healthy eating patterns, which in turn support brain development during the critical early years of life. Therefore, promoting oral health in

preschool children not only contributes to preventing oral health problems but also plays a crucial role in preventing future chronic diseases .(Stewart *et al.*, 2022)

To improve public health, the Safe Community concept has been widely adopted as a comprehensive approach that creates health-supporting environments through multi-sectoral collaboration, community empowerment, and the utilization of innovative technology. This approach allows communities not only to improve access to healthcare services but also to encourage the adoption of sustainable healthy habits. (Nayee *et al.*, 2018; Vered *et al.*, 2022)

Various innovations have been developed to support preschool children's oral health in safe communities. School-based programs, such as the PRECEDE-PROCEED model, have shown success in improving access to dental services for vulnerable groups. Home-based interventions involving motivational interviews by health workers have also

been effective in improving family dental health literacy. In addition, the use of digital technology, (Cartes-Velasquez *et al.*, 2017) such as mobile applications providing education and oral health monitoring, has been proven effective in reducing oral health issues in preschool children. (Shirmohammadi *et al.*, 2022)

However, despite a growing understanding of the relationship between oral health, brain development, and the prevention of chronic diseases such as stroke, research explicitly integrating these three aspects within the Safe Community framework remains limited. Therefore, this study aims to explore how oral health promotion in preschool children within safe communities can bridge healthy brain development and stroke prevention. The findings of this study are expected to provide deeper insights for the development of sustainable, evidence-based public health programs.

Oral health in preschool children is a key element in supporting healthy growth and development, including brain development and long-term quality of life. Oral health issues, such as dental caries and gingivitis, can affect nutritional intake, sleep quality, and cognitive function in children. (Vaughan, 2009; Ramos-Gomez, Kinsler and Askaryar, 2020; Corchuelo-Ojeda, Casas-Arcila and Soto-Llanos, 2024) However, the deeper relationship between preschool children's oral health and brain development has not been thoroughly explored. Community-based innovations, such as school-based programs, (Stewart *et al.*, 2022) home interventions, (Cartes-Velasquez *et al.*, 2017) and digital technology, (Shirmohammadi *et al.*, 2022) offer opportunities to improve oral health in this vulnerable age group. The Safe Community approach, (Vaughan, 2009) which includes multi-sectoral collaboration (Ramos-Gomez, Kinsler and Askaryar, 2020) and community empowerment, (Maureen C. Kenny, 2015; Boeke *et al.*, 2024) has the potential to create an environment that supports children's oral health while reducing the risk of chronic diseases such as stroke in the future. However, how this approach can be effectively applied to support oral health, brain development, and stroke prevention remains a challenge that requires further understanding.

Method

This study employs a narrative approach to explore the relationship between preschool children's oral health, brain development, and stroke prevention within the context of a Safe Community. This method is designed to integrate scientific evidence and community-based innovations to provide a holistic understanding of the research topic.

1. Writing Approach

The writing approach is thematic and descriptive, aiming to connect the results of previous studies with innovations implemented in various communities. This process involves a critical analysis of relevant literature, focusing on grouping evidence based on the main topics: preschool children's oral health, brain development, and chronic disease risks such as stroke.

2. Data Sources

The literature data analyzed in this study were obtained from various trusted sources, including major scientific databases such as PubMed and Scopus. A total of 20 journal articles, including primary and secondary studies, relevant to the research theme, were selected. The selected literature was published within the last 15 years to ensure its relevance to current developments in public health, community innovations, and oral health technology.

3. Search Keywords

The literature search process utilized a combination of keywords to ensure adequate coverage of the research topic. Keywords used include: Preschool oral health, Safe Community, Brain development, Stroke prevention, and Community innovations. These keywords were combined in various combinations using logical operators such as "AND," "OR," and "NOT" to obtain specific yet comprehensive results.

4. Inclusion and Exclusion Criteria

Literature selection was based on the following inclusion and exclusion criteria:

Inclusion Criteria: Studies discussing preschool children's oral health in relation to brain development and stroke risk. Articles exploring community-based innovations such as school-based programs, home interventions, and digital technology. Research involving Safe Community approaches in promoting preschool children's oral health.

Exclusion Criteria: Articles focused on populations outside preschool age or without explicit relevance to children's oral health. Studies with geographically or demographically limited contexts, making generalization difficult. Literature unavailable in English or languages supporting analysis in this study.

5. Data Analysis Process

Data obtained from the selected literature were analyzed thematically to identify patterns, relationships, and gaps in previous research. The analysis focused on community-based innovations, the biological mechanisms linking oral health with brain development, and preventive approaches to stroke risk through oral health interventions. These findings were organized within a narrative framework to provide holistic and comprehensive insights.

Result

Oral Health in Preschool Children and Brain Development

Oral health in preschool-aged children is a critical aspect of supporting optimal growth and development, including brain development. However, oral health issues such as dental caries and periodontal diseases remain significant challenges in this age group. Dental caries, being the most common disease among children, can directly impact nutritional status due to eating difficulties caused by pain and discomfort. Children experiencing dental pain often have limited food intake, which can lead to deficiencies in essential nutrients like protein, iron, and vitamins, all of which play a key role in brain development and can affect the child's quality of life. (Oliveira, Sheiham and Bönecker, no date; Colombo and Bianchi, 2012; Liang *et al.*, 2015; Chai *et al.*, 2020; Perazzo *et al.*, 2020) Furthermore, periodontal diseases and dental infections can trigger the release of inflammatory mediators such as pro-inflammatory cytokines, including interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF- α). These mediators can enter the systemic circulation and affect brain function through systemic inflammatory mechanisms. Research shows that chronic inflammation in childhood can interfere with brain neuroplasticity, contributing to delays in cognitive and emotional development. (Moutsopoulos and Madianos, 2006; Higashi *et al.*, 2009; Saini, Saini and Saini, 2010, 2011; Rodella *et al.*, 2011; Yumoto *et al.*, 2012; Ramadan *et al.*, 2020)

Longitudinal studies also indicate that poor oral health during the preschool years can have long-term effects on educational performance. (Oliveira, Sheiham and Bönecker, no date; Colombo and Bianchi, 2012) Children with a history of severe caries are more likely to experience school absenteeism due to oral health complications, which reduces learning time and opportunities for cognitive development. (Oliveira, Sheiham and Bönecker, no date; Colombo and Bianchi, 2012; Guarnizo-Herreño and Wehby, 2012; Liang *et al.*, 2015; Chai *et al.*, 2020) Therefore, ensuring good oral health during preschool not only contributes to physical health but also supports healthy brain development.

The link between oral health and brain development is also supported by the fact that poor dental health can increase physiological and psychological stress in children. Prolonged stress can affect brain circuits involved in emotion regulation and cognition. (Arrow, Raheb and Miller, 2013; Janus *et al.*, 2019; Navarro Betetta and Perona Miguel de Priego, 2022; Nam and Oh, 2024; Watt *et al.*, 2024) Hence, early intervention to maintain oral

health is crucial, not only to prevent direct impacts on oral health but also to protect brain development from risks associated with inflammation and chronic stress.

Stroke Prevention through Oral Health Promotion

Preschool oral health not only impacts cognitive development but also plays a key role in preventing chronic diseases like stroke. Chronic inflammation caused by oral health issues such as dental caries and periodontal disease has been identified as a major risk factor for various cardiovascular diseases, including stroke. This inflammatory process is mediated by the release of pro-inflammatory cytokines such as tumor necrosis factor-alpha (TNF- α), which can damage the vascular endothelium and accelerate atherosclerotic plaque formation. (Moutsopoulos and Madianos, 2006; Saini, Saini and Saini, 2010, 2011; Rodella *et al.*, 2011)

Studies show that chronic inflammation originating from the oral cavity can contribute to systemic vascular dysfunction. This condition increases the risk of thrombus formation and ischemic stroke, particularly in individuals with other risk factors like hypertension or diabetes mellitus. In preschool-aged children, although stroke is rare, early prevention through oral health promotion can reduce the accumulation of risks that may develop in adulthood.

Epidemiological evidence strengthens the link between poor oral health and cardiovascular diseases. A cohort study found that individuals with periodontitis have a higher risk of stroke compared to those with good oral health. These data underscore the importance of maintaining oral health from the earliest stages of life to prevent long-term chronic inflammation

Table 1. Relationship Between Oral Health and Systemic Vascular Dysfunction

Factor	Impact on Systemic Health	Supporting Studies
Chronic Oral Inflammation	Leads to systemic inflammation, contributing to vascular dysfunction and increased stroke risk	(Craig, 2004; Humagain, and Uppoor, 2006; Segura-E <i>et al.</i> , 2012; Lafon <i>et al.</i> , Maciąg <i>et al.</i> , 2014; Li, C and Lin, 2022)
Periodontitis	Associated with endothelial dysfunction and higher systemic inflammatory markers	(Lafon <i>et al.</i> , 2013; Maciąg <i>et al.</i> , 2014; Li, Ouyang and Lin, 2022; Finck <i>et al.</i> , 2023)
Hypertension and Diabetes	Exacerbate the impact of oral inflammation on	(Turanjanin <i>et al.</i> , 2012; Vatsolaki <i>et al.</i> , 2024)

systemic vascular health

Early Oral Health Promotion
Reduces risk factors accumulation, improving long-term systemic health outcomes
(Son, Lim and Kim, 2017; Shan *et al.*, 2023; Ahmad Tajudin *et al.*, 2024; Vatsolaki *et al.*, 2024)

Dental Health Promotion for Preschool Children as a Preventive Measure

Promoting dental health in preschool-aged children can be a significant preventive step in reducing the burden of diseases later in life. Community-based programs, such as school-based dental health campaigns or home visits with motivational interviewing, have shown effectiveness in improving oral health and reducing risk factors associated with inflammation. Additionally, technologies such as digital apps for monitoring dental health offer new opportunities for supporting disease prevention from an early age.

Integrating oral health promotion into broader public health strategies, particularly through a **Safe Community** approach, can create a significant impact. This approach enables multi-sectoral engagement, including healthcare professionals, educators, and community stakeholders, to ensure that oral health interventions reach the populations most in need.

In the context of stroke prevention, these efforts not only reduce the disease burden but also provide long-term benefits for the overall well-being of the community. By improving preschool dental health, we can reduce the risk of chronic inflammation and lay the foundation for a healthier generation.

Innovations in Dental Health Promotion within Safe Communities

Promoting dental health for preschool children through a Safe Community approach requires the implementation of innovative, holistic, and evidence-based strategies. Innovations such as school-based programs, home-based interventions, and digital technologies provide significant opportunities to improve oral health and create sustainable impacts in communities.

1. School-Based Programs

School-based programs have proven to be one of the most effective ways to increase access to dental services for preschool children, especially in resource-limited areas. One model used is the PRECEDE-PROCEED model, which takes into account social, epidemiological, and policy factors in designing interventions. This model allows for multi-sectoral involvement, including schools, healthcare professionals, and the community, to enhance the coverage and

effectiveness of the program.(Stewart *et al.*, 2022)Studies in rural communities have shown that implementing school-based programs improves dental health literacy among children and their families. These programs often include tooth-brushing training, routine dental check-ups, and topical fluoride treatments, which have been proven to reduce the prevalence of dental caries. Moreover, the involvement of teachers in these programs strengthens sustainability and ensures the integration of oral health habits into children's daily routines.

2. Home-Based Interventions

Home-based interventions involving visits from healthcare professionals have shown success in improving dental health behaviors in preschool children, particularly in underserved communities. One effective approach is **Motivational Interviewing (MI)**, a communication method designed to increase family awareness and commitment to oral health. (Cartes-Velasquez *et al.*, 2017) Home visits provide an opportunity to understand the specific context of each family, including social and cultural barriers that affect health behaviors. A study in Chile showed that MI-based home visits significantly improved adherence to oral health habits in families at high risk of dental caries. This approach also helps build better relationships between families and healthcare providers, which ultimately increases access to preventive services.

3. Digital Technologies

Technological advances have opened up new opportunities to promote dental health through digital apps. Mobile apps designed to support dental health habits in children offer interactive education, reminders for brushing teeth, and step-by-step guides for parents. This technology allows for continuous, personalized education based on individual needs. (Shirmohammadi *et al.*, 2022) Recent studies show that dental health apps used by parents can significantly reduce the incidence of gingivitis and improve adherence to oral hygiene routines. Additionally, these apps provide real-time data that can be utilized by healthcare providers to monitor a child's oral health progress. Integrating digital technologies into community-based strategies also allows for broader community engagement. For example, dental health campaigns using social media and other digital platforms have successfully raised awareness about the importance of oral health in remote communities. These innovations reflect an adaptive, evidence-based approach to addressing the challenges of preschool dental health. By combining school-based programs, home interventions, and digital technologies, communities can create environments that support

children's oral health while contributing to the prevention of systemic diseases in the future.

The Safe Community Approach to Supporting Child Health

The **Safe Community** approach has been widely recognized as a holistic framework for improving public health through multi-sectoral integration, community empowerment, and the use of technological innovations. This approach is not only relevant to general public health but is also highly effective in supporting child health, including preschool dental health, which has long-term impacts on cognitive development and systemic health.

Pillars of Safe Community

The Safe Community approach is based on three complementary pillars:

1. Multi-Sectoral Collaboration:

This approach involves collaboration between various sectors, including government, non-governmental organizations, the private sector, healthcare providers, and the community. The goal is to ensure that health resources, information, and services are inclusively available and accessible to all groups. In the context of preschool dental health, this collaboration involves the engagement of schools, parents, and dental professionals to ensure continuous intervention. (Vaughan, 2009) (Ramos-Gomez, Kinsler and Askaryar, 2020)

2. Community Empowerment:

Empowering the community is at the heart of the Safe Community approach. By increasing health literacy and providing the necessary tools to support health, communities can actively participate in maintaining their well-being. Campaigns focused on behavior change and improving dental health literacy have proven successful in encouraging healthy habits at the community level. (Maureen C. Kenny, 2015; Boeke *et al.*, 2024)

3. Technological Innovation:

Technology plays a key role in enhancing the effectiveness of the Safe Community approach. The use of digital technologies, such as dental health apps, data-driven health monitoring tools, and social media, has successfully reached broader populations and provided interactive, personalized health education.

Discussion

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Conclusions and Suggestions

1. The Relationship between Oral Health and Brain Development

This study highlights the importance of preschool dental health in supporting optimal brain development. Good oral health not only prevents pain and discomfort but also ensures adequate nutrient intake to support brain growth and function. Children with poor oral health often face limitations in consuming nutrient-rich foods due to dental pain or infections, which can affect cognitive development. Furthermore, poor dental health is often associated with increased systemic inflammation, which can affect brain neuroplasticity and long-term cognitive function. Therefore, early dental health interventions are critical to supporting neurological development

and reducing the risk of cognitive disorders later in life.

2. The Role of Safe Community in Oral Health Promotion

The Safe Community approach has proven to be an effective strategy for promoting child health, including dental health. By creating a conducive environment through multi-sectoral collaboration, community empowerment, and the use of technology, this approach can ensure better access to dental health services for preschool children. Collaboration between schools, healthcare professionals, and the community allows for the implementation of structured school-based programs that increase dental health literacy. Innovations such as digital apps to monitor brushing habits and community-based health campaigns, such as "Watch Your Mouth," have successfully raised awareness and improved dental health behaviors. Moreover, the Safe Community approach provides space for community empowerment in leading sustainable behavior change. Active community involvement in designing and implementing dental health programs not only enhances program effectiveness but also ensures greater sustainability and better acceptance within the community.

3. The Potential for Stroke Prevention through Oral Health

This study also shows that promoting dental health in preschool children can be an important part of chronic disease prevention strategies, such as stroke. Oral health problems like caries and periodontal disease often trigger chronic inflammation, which is a known risk factor for cardiovascular diseases, including stroke. By reducing systemic inflammation through improved oral health, the risk of stroke later in life can be minimized. Community-based approaches integrated with Safe Community public health policies can significantly impact the reduction of disease burden. Programs like home-based interventions using motivational interviewing have shown success in improving dental health behaviors, which ultimately contribute to reducing systemic risk factors. In the future, leveraging digital technology to support healthy habits could be one effective way to promote chronic disease prevention through early dental health promotion.

Recommendations

1. **For Practice:** Integrate community-based dental health programs into broader public health strategies to support preschool child development. Use digital technologies to improve accessibility

and effectiveness of dental health promotion in remote communities.

2. **For Policy:** Encourage the development of Safe Community-based health policies that include preschool dental health promotion as a national priority. Support investments in innovative technologies to expand dental health services and prevent systemic diseases in the future.
3. **For Research:** Conduct longitudinal studies to evaluate the impact of dental health on children's brain development and cardiovascular disease risks later in life. Test the effectiveness of technology-based innovations in supporting dental health promotion, especially in communities with limited healthcare access.

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