DYNAMICS OF CHILD'S ORAL MICROBIOTA: A REVIEW

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Abstract:

The oral microbiota in children changes with growth and development. The composition of the microbiota is influenced by genetic factors, oral environment, diet, and oral hygiene habits. Changes in oral microbiota composition have significant health implications in children, that is can contribute to the development of dental diseases, such as dental caries and periodontal disease. In addition, oral microbiota also plays an important role in the development of the child's immune system, therefore it is very important to understand the dynamics of child's oral microbiota. The method used in writing this scientific article is the literature review method. Various studies on oral microbiota in children show that in early life, oral microbiota is dominated by bacteria such as Streptococcus, Prevotella, and Veillonella. Along with the introduction of solid foods and the development of teeth, the composition of oral microbiota will change and become more diverse. Genetic factors can influence a child's susceptibility to the growth of pathogenic bacteria, while the oral environment, diet, and oral hygiene habits play an important role in the diversity and balance of oral microbiota. A balanced composition of microbiota plays a role in preventing dental diseases and maintaining overall oral health. Maintaining oral hygiene and adopting a healthy diet are important factors in maintaining the health of a child's oral microbiota. In addition, an understanding of the relationship between oral microbiota and a child's immune system is also an important factor in maintaining overall health.

Keywords: *Oral microbiota, Streptococcus, Prevotella, and Veillonella*

Abstrak:

Mikrobiota oral pada anak-anak berubah seiring pertumbuhan dan perkembangan. Komposisi mikrobiota dipengaruhi oleh faktor genetik, lingkungan mulut, pola makan, dan kebiasaan kebersihan mulut. Perubahan komposisi mikrobiota oral memiliki implikasi kesehatan yang signifikan pada anak-anak, yaitu dapat berkontribusi pada perkembangan penyakit gigi, seperti karies gigi dan penyakit periodontal. Selain itu, mikrobiota oral juga berperan penting dalam perkembangan sistem imun anak, oleh karena itu sangat penting untuk memahami dinamika mikrobiota oral anak. Metode yang digunakan dalam penulisan artikel ilmiah ini adalah metode tinjauan pustaka. Berbagai penelitian tentang mikrobiota oral pada anak menunjukkan bahwa pada awal kehidupan, mikrobiota oral didominasi oleh bakteri seperti *Streptococcus, Prevotella*, dan *Veillonella*. Seiring dengan pengenalan makanan padat dan perkembangan gigi, komposisi mikrobiota oral akan berubah dan menjadi lebih beragam. Faktor genetik dapat mempengaruhi kerentanan anak terhadap pertumbuhan bakteri patogen, sementara lingkungan mulut, diet, dan kebiasaan kebersihan mulut memainkan peran penting dalam keragaman dan

keseimbangan mikrobiota mulut. Komposisi mikrobiota yang seimbang berperan dalam mencegah penyakit gigi dan menjaga kesehatan mulut secara keseluruhan. Menjaga kebersihan mulut dan menerapkan pola makan yang sehat merupakan faktor penting dalam menjaga kesehatan mikrobiota oral anak. Selain itu, pemahaman tentang hubungan antara mikrobiota oral dan sistem kekebalan tubuh anak juga merupakan faktor penting dalam menjaga kesehatan secara keseluruhan.

Kata Kunci: *Mikrobiota Oral, Streptococcus, Prevotella, dan Veillonella*

INTRODUCTION

The oral microbiota is a complex and dynamic ecosystem within the human oral cavity. The community in this ecosystem consists of different types of bacteria, viruses, and fungi. The dynamics of oral microbiota in children are very important to understand because they can affect their overall oral and dental health. Poor dental health conditions in children can harm their growth and development, as well as their overall quality of life (Sedghi et al., 2021; Wade & Prosdocimi, 2020; Xiao et al., 2020).

The role of oral microbiota on dental health is widely known. Studies have shown that changes in the composition of a child's oral microbiota can contribute to the development of dental diseases, including dental caries and periodontal disease (Sedghi et al., 2021; Wade, 2021). Dental caries is the most common dental disease in children, and has a significant impact on their quality of life (Ma et al., 2015; Tanzer, Livingston, & Thompson, 2001). Periodontal disease, which involves gum inflammation and damage to the supporting tissues of teeth, can also occur in children if the oral microbiota is out of balance (Hurley, 2017; Sedghi et al., 2021; Solbiati et al., 2018; Xiao et al., 2020).

Recent research has provided deeper insights into the composition of a child's oral microbiota. Through the use of DNA sequencing methods and other molecular techniques, researchers were able to identify microorganisms present in the oral microbiota of children. The study by Lee H et al. (2020) showed that the composition of oral microbiota in children with dental caries differed significantly from children whose teeth were healthy. Increased numbers of acid-producing bacteria, such as *Streptococcus mutans*, have been linked to an increased risk of dental caries in children.

The factors that influence the composition of a child's oral microbiota are important to understand. Genetic factors can play a role in determining an individual's predisposition to colonization of certain bacteria. Genetic studies by Demmitt et al. (2017) suggest that genetic factors may influence oral microbiota diversity in children.

The oral environment is also an important factor in shaping a child's oral microbiota. Factors such as pH, temperature, humidity, and the presence of substrates, such as food waste, can affect the growth and survival of certain microorganisms. Research by Lawal et al. (2022) suggests that optimal oral environments, such as pH-balanced and low sugar levels, can support healthy oral microbiota growth in children.

Diet and diet also play an important role in shaping a child's oral microbiota. Dietary consumption high in sugars and carbohydrates can provide a substrate for acid-producing

bacteria, which contributes to the development of dental caries. For example, research by (Hancock et al., 2020; Moynihan, 2016) showed that high consumption of added sugars is associated with an increased risk of dental caries in children.

In addition, oral hygiene habits can also affect a child's oral microbiota. Habits such as brushing your teeth, using dental floss, and using mouthwash can affect the growth and survival of certain microorganisms in the mouth. Research by (Belstrøm et al., 2018; Lawal et al., 2022; Shaghaghian et al., 2015; Soldo et al., 2020) suggests that regular good brushing habits can help maintain oral microbiota balance in children.

A deep understanding of the dynamics of oral microbiota in children has important implications for the prevention and management of dental diseases. By understanding the changes in the composition of a child's oral microbiota as they grow and develop, as well as the factors that influence it, we can develop more effective prevention strategies and appropriate interventions to maintain children's dental health.

In this review, various empirical data from relevant research on the dynamics of oral microbiota in children have been collected and analyzed. Exploration of changes in oral microbiota composition as children grow and develop, identifying factors that influence them, and associated health implications are reviewed in this review. As such, this review could make an important contribution to our understanding of the role of oral microbiota on children's dental and oral health, as well as provide a basis for the development of more effective dental disease prevention and management strategies in children.

LITERATURE REVIEW

In the scientific literature, theories and research regarding the dynamics of oral microbiota in children continue to develop. These studies provide a solid theoretical foundation for understanding changes in a child's oral microbiota composition, as well as the factors that influence it.

The succession of microbial colonization: The succession of microbial colonization describes changes in the composition of a child's oral microbiota as they grow and develop. At first, the newborn's mouth tends to be sterile, but immediately after birth, microbial colonization begins. This theory states that aerobic bacteria such as *Streptococcus, Neisseria*, and *Veillonella* were early colonizers, followed by anaerobic bacteria such as *Prevotella*, *Fusobacterium*, and Actinomyces as children entered the solid food introduction stage. Longitudinal studies tracking changes in children's oral microbiota composition have provided a better understanding of the succession of those microbes (Lee H, Lee S, 2020).

Genetic factors in oral microbiota composition: Genetic factors play an important role in determining a child's oral microbiota composition. Genomic studies have identified associations between individual genetic variation and oral microbiota diversity. For example, studies using the twin-familial method have shown that similarities in oral microbiota composition tend to be higher in individuals who have a closer genetic relationship (Si et al., 2017).

Influence of diet and diet: the diet of children affects the composition of their oral microbiota. A diet high in sugar or carbohydrates can affect the growth of acid-producing bacteria such as *Streptococcus mutans*, which are linked to the risk of dental caries in children. Conversely, the consumption of fibre and nutrient-rich foods such as fruits and vegetables can promote healthy oral microbiota diversity (Chen et al., 2022).

Oral hygiene habits: oral hygiene habits such as brushing, the use of dental floss, and the use of mouthwash also have an impact on the composition of a child's oral microbiota. Regular use of toothpaste with fluoride can help reduce the number of acid-producing bacteria, while the use of dental floss helps reduce plaque and control bacterial growth (Marsh, 2010).

METHODS

The method used in writing this scientific article is the literature review method. We traced various literature relevant to the problem studied, namely Exploring changes in oral microbiota composition as children grow and develop, identifying factors that influence them, and related health implications. The collected data and information are selected so that the required scientific data and information are obtained and then compiled in a sub-subject, namely dynamics of oral microbiota in children.

DISCUSSION

Composition of oral microbiota in Children

Studies on the composition of children's oral microbiota have identified different types of microorganisms that can be found in their oral cavity. One of the most common types of microorganisms is bacteria. Research shows that a large number of bacterial genera are found in a child's oral microbiota, including *Streptococcus, Veillonella, Neisseria,* and *Actinomyces* (Grier et al., 2021). In addition to bacteria, a child's oral microbiota also contains viruses, such as bacteriophages, and fungi, such as Candida (Kim et al., 2021).

The composition of a child's oral microbiota undergoes significant changes as they grow and develop. In newborns, oral microbiota is generally dominated by aerobic bacteria such as *Streptococcus, Neisseria,* and *Veillonella.* Research suggests that factors such as mode of delivery, breastfeeding or formula, and antibiotic use may affect the composition of the oral microbiota in infants (Hurley et al., 2019; Ruiz et al., 2019; Yang et al., 2016).

Along with the introduction of solid foods and the development of teeth, the composition of a child's oral microbiota changes significantly. Longitudinal studies by (Yang et al., 2012) showed that the introduction of solid foods in children aged 6-24 months correlated with an increase in the number of anaerobic bacteria such as *Prevotella*, *Fusobacterium*, and *Actinomyces* in the oral microbiota. These changes are in line with changes in the oral environment that are more complex with the presence of new sources of nutrients for microorganisms.

As children grow into older children, the composition of their oral microbiota is constantly changing. The study by (Crielaard et al., 2011) showed that in children aged 4-12 years, oral microbiota has a more complex composition compared to newborns. *Streptococcus* bacteria remain one of the dominant bacterial genera in the oral microbiota of children (Korona-Glowniak et al., 2022). In addition, bacteria of the genera *Actinomyces, Veillonella*, and *Neisseria* also remain present in significant numbers in the oral microbiota of larger children (Chalmers et al., 2015).

The dominant bacteria in a child's oral microbiota, such as *Streptococcus*, have an important role in the balance of the child's oral environment and dental development. For example, Streptococcus mutans, which is a species of the genus *Streptococcus*, is known to have the ability to produce acid and may contribute to the development of dental caries in children (Loesche, 1986). These bacteria can absorb sugar in food and drinks consumed by children, and turn them into acids that damage the enamel lining of teeth. In addition, the dominant bacteria in the oral microbiota of children also play a role in the carbohydrate fermentation process. *Streptococcus* is a major producer of lactic acid through the process of glucose fermentation, which can affect the pH of the oral environment. pH imbalances can affect dental health and trigger the growth of pathogenic bacteria (Tanzer et al., 2001).

In addition to the role of dental disease, dominant bacteria in a child's oral microbiota may also contribute to interactions with a child's immune system. Some research suggests that oral microbiota can interact with immune system cells in a child's oral cavity and influence the immune response to microbial pathogens (Alemao et al., 2021).

Changes in oral microbiota composition as growth and development

In general, changes in oral microbiota composition along with a child's growth and development are the result of early colonization in the newborn, the introduction of solid foods, and the influence of the child's growth and development. When newborns are born, their oral cavity is still sterile, but immediately after birth, the first colonization of microorganisms begins. Studies have shown that this early colonization is influenced by several factors, including the mode of delivery and early feeding of the baby.

The study by Bokulich et al. (2016) suggests that babies born vaginally tend to have an early oral microbiota composition that is more similar to the mother's vaginal microbiota. On the other hand, babies born by cesarean section tend to have an oral microbiota composition that is more similar to a hospital environment. This suggests that the process of childbirth can affect the initial colonization of microorganisms in the oral cavity of the baby.

Breastfeeding or formula feeding can also affect the composition of oral microbiota in infants. Studies have shown that exclusively breastfed infants tend to have a more diverse and balanced oral microbiota composition compared to formula-fed infants (Penders et al., 2006). Breast milk contains natural prebiotics and probiotics that can support the growth of beneficial bacteria in the baby's oral cavity.

One significant change in the composition of a child's oral microbiota occurs with the introduction of solid foods. As babies begin to introduce solid foods other than breast milk or formula, the composition of their oral microbiota changes drastically. As children begin to eat solid foods, including foods that are more complex in texture and nutrition, their oral environment becomes more diverse and supports the growth of different bacteria. The study by Yang et al. (2012) showed that the introduction of solid foods in children aged 6-24 months is associated with an increased number of anaerobic bacteria in the oral microbiota, such as *Prevotella, Fusobacterium, and Actinomyces*. This suggests that solid foods provide a new source of nutrients for microorganisms in the oral cavity, leading to changes in the composition of the child's oral microbiota.

The introduction of solid foods is also associated with increased diversity of microorganisms in the oral microbiota. The study by (Ling et al., 2010) showed that the introduction of solid foods in children aged 2-3 years correlated with increased diversity of bacterial species in the oral microbiota. The addition of a variety of solid foods helps create more complex environmental conditions in the oral cavity, which can support the diversity of oral microbiota.

Changes in the composition of oral microbiota also occur along with the growth and development of children. During a child's growing years, changes in their oral environment and diet can affect the composition of the oral microbiota. Longitudinal studies by Pinto (2019) showed that changes in the oral microbiota composition of children aged 3-9 years were associated with the growth of permanent teeth. These changes reflect changes in the oral environment caused by teething and changes in a child's diet as they enter the solid food phase.

The growth and development of a child's immune system can also affect the composition of oral microbiota. Research shows that hormonal changes and immune responses associated with a child's growth and development can affect the composition of their oral microbiota (Dzidic et al., 2018). The interaction between the child's immune system and microorganisms in the oral cavity can form a distinctive pattern of microbiota composition.

Factors-factors that affect a child's oral microbiota

Genetic factors have an important role in determining the composition of a child's oral microbiota. Research on identical and non-identical twin brothers shows that genetic factors affect the diversity of microorganisms in the oral cavity. The study also suggests that individual genetics may influence the presence and abundance of certain microbial species in the oral microbiota. Geneticization of the immune system can also affect the composition of oral microbiota. Different individual immune systems can provide different conditions in the oral cavity, which in turn affects the growth and composition of the microbiota (Segata, 2012).

The oral environment that is unique to each individual also plays an important role in shaping the composition of a child's oral microbiota. Environmental factors, such as pH, humidity, temperature, and nutrient availability, can affect the growth and survival of

microorganisms in the oral cavity. One example of a significant environmental factor is acidity (pH) in the oral cavity. Certain bacteria, such as *Streptococcus mutans*, tend to multiply in an acidic oral environment. Consumption of foods or drinks that are high in sugar can increase the acidity of the mouth, creating an environment that supports the growth of caries bacteria such as *S. mutans* (Forster et al., 1986; Matsumoto-Nakano, 2018).

Diet and diet play a key role in shaping the composition of a child's oral microbiota. The food consumed by children can provide nutrients for microorganisms in the oral cavity, and the composition of these nutrients can affect the growth of different bacteria. Research by (Holgerson et al., 2013) showed that children who were given additional foods such as solid foods and desserts tended to have a different oral microbiota composition compared to those who only got breast milk or formula. Solid foods rich in fibre, such as fruits and vegetables, can support the growth of beneficial bacteria in the oral cavity, while consumption of foods high in sugar can promote the growth of pathogenic bacteria associated with dental caries (Hancock et al., 2020).

Oral hygiene habits also affect the composition of a child's oral microbiota. Research shows that the frequency of brushing your teeth and using mouthwash can affect the number and type of microorganisms in the oral cavity. A study by Hallang et al. (2021) Shows that the habit of brushing your teeth regularly and with the right method can reduce the number of pathogenic bacteria in the oral cavity. The use of mouthwash can also provide antimicrobial effects that help reduce the number of pathogenic bacteria. However, excessive use of mouthwash can cause an imbalance of oral microbiota and affect the growth of beneficial bacteria(Bryan et al., 2022). In addition, research (Liu, 2017) suggests that nail-biting, finger-sucking, or pacifier-using habits may affect the composition of a child's oral microbiota. This habit can introduce new microorganisms into the child's oral cavity and affect the balance of microbiota (Teich et al., 2020).

The implication of Children's oral Microbiota health

Changes in the composition of the oral microbiota in children can have consequences for dental health. Several studies have shown a link between changes in oral microbiota with the development of dental diseases such as dental caries and periodontal disease. The study by Holgerson et al. (2013) found that the oral microbiota composition of children fed solid foods and desserts was different from those who only got breast milk or formula. Children who receive solid foods tend to have a more diverse microbiota composition and are rich in beneficial bacteria, whereas children who get breast milk or formula tend to have a more homogeneous microbiota composition and are dominated by certain bacteria. This suggests that the food a child consumes may affect the composition of the oral microbiota and potentially affect the risk of dental disease.

In addition, research by Rosier (2018) revealed that changes in oral microbiota composition caused by environmental factors, such as diet and frequency of sugar consumption, can contribute to the development of dental caries. Some bacteria, such as *Streptococcus mutans*, are known to be involved in the process of dental plaque formation

and acid production that damages tooth enamel (Loesche, 1986). Changes in the composition of oral microbiota that facilitate the growth of caries bacteria can increase the risk of dental caries in children.

Children's oral microbiota also play a role in the development of their immune system. Studies have shown that the interaction between microorganisms in the oral cavity and the child's immune system plays an important role in the formation of a balanced immune response. A study by Belstrøm et al. (2014) found that children with periodontal disease had different salivary bacterial profiles compared to healthy children. Children with periodontal disease tend to have higher numbers of pathogenic bacteria, whereas healthy children have more bacteria that play a role in maintaining the balance of the oral microbiota. This study suggests that the composition of oral microbiota can influence a child's oral health and immune system. In addition, several studies have shown that oral microbiota can interact with a child's immune system and influence the development of immune responses. Certain BactBacteriaa child's oral microbiota can interact with immune cells and affect immune activity. These interactions can aid in the formation of appropriate immune responses and help protect the child from infection and disease (Parigi et al., 2015).

The composition of oral microbiota in children may have long-term health implications. Longitudinal studies that followed children from childhood to adulthood suggest that oral microbiota composition early in life may influence their oral health later in life. A child with a healthy oral microbiota composition at an early age has a lower risk of developing dental caries and periodontal disease in adulthood. In this study, children with high microbiota diversity and numbers of beneficial bacteria at an early age were less likely to develop dental and oral health problems in the future (Grier et al., 2021; Xiao et al., 2020).

In addition, research by Marsh et al. (2015) presents the concept of "oral ecology" that explains how oral microbiota balance can affect long-term health. Changes in oral microbiota composition that lead to microbiota imbalances can lead to conditions such as dysbiosis and inflammation, which can contribute to the development of periodontal disease, heart disease, and other systemic disorders.

CONCLUSION

A child's oral microbiota changes with growth and development. The composition of the microbiota is influenced by genetic factors, oral environment, diet, and oral hygiene habits. Changes in microbiota composition have an impact on dental health, the immune system, and the risk of dental disease. This review suggests that oral microbiota early in life has an effect on oral health in adulthood. Children's oral microbiota care should pay attention to these factors to prevent dental and oral health problems.

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