The distribution of *Streptococcus mutans* and *Streptococcus sobrinus* in children with dental caries severity level

Nur Dianawati,1 Wahyu Setyarini,2 Ira Widjiastuti,3 Rini Devijanti Ridwan4 and K. Kuntaman5

1Post-graduate Program of Basic Medical Science, Faculty of Medicine, Universitas Airlangga
2Institute of Tropical Disease, Universitas Airlangga
3Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga
4Department of Oral Biology, Faculty of Dental Medicine, Universitas Airlangga
5Department of Clinical Microbiology, Faculty of Medicine, Universitas Airlangga and Dr. Soetomo Hospital
Surabaya – Indonesia

ABSTRACT

**Background:** The prevalence of dental caries is high worldwide and specifically in Indonesia, especially in children. Cariogenic bacteria are the major cause of dental caries. *Streptococcus mutans* (*S. mutans*) is one of the bacteria often associated with caries, due to its ability in producing acid and forming the biofilm for bacterial colonisation on the surface of oral cavities. In addition to *S. mutans*, *Streptococcus sobrinus* (*S. sobrinus*) bacteria are also thought to play an important role in the process of caries. **Purpose:** This study aims to analyse the distribution of *S. mutans* and *S. sobrinus* in children with seriously high dental caries levels. **Methods:** This study was an observational analytical study. Bacterial isolation was conducted in carious lesions of 50 paediatric patients 6-12 years old with superficial dental caries. Samples of caries lesions were put directly into a tube containing the Brain Heart Infusion Broth (BHI-B) and incubated at 37°C for 24 hours. The samples were sub-cultured on selective tryptone yeast cystine sucrose bacitracin (TYCSB-Himedia) agar, and then incubated for two days. Bacterial identification was then performed using the polymerase chain reaction (PCR) Multiplex method. Statistical analysis with Chi-square. **Results:** The total number of children with dental caries included in this study was 50. Among these, 94% showed positive for *S. mutans* and 30% positive for *S. sobrinus*. The analysis of the prevalence of bacterial colonisation (*S. mutans* and *S. sobrinus*) based on caries severity and the Simplified Oral Hygiene Index (OHI-S), showed there was no significant difference (p> 0.05). **Conclusion:** This study showed that among 50 caries noted in the children, 94% were colonised *S. mutans* and 30% *S. sobrinus*. There was no significant difference between the colonisation of *S. mutans* and *S. sobrinus* among children from the severe to mild decayed exfoliated filling teeth (DEFT) category, and between bad and good OHI-S.

**Keywords:** caries severity; dental caries; OHI-S; *Streptococcus mutans*; *Streptococcus sobrinus*

Correspondence: K. Kuntaman, Department of Clinical Microbiology, Faculty of Medicine, Universitas Airlangga. Jl Mayjend. Prof. Dr Moestopo 47 Surabaya 60132, Indonesia. Email: kuntaman@fk.unair.ac.id

INTRODUCTION

Dental caries is a serious oral health problem in Indonesia and the rest of the world. Based on the 2018 Basic Health Research (RISKESDAS) data, the prevalence of caries in Indonesia was significantly high, above the World Health Organization (WHO) target.1,2 According to the RISKESDAS data, the prevalence of caries reached 93% in children aged between five and six years, while WHO and Federation Dentaire Internationale (FDI) had a target to make 50% of children free of dental caries. The decay missing filling teeth (DMFT) index for primary teeth in children at these ages was 8.43, indicating severe early childhood caries were found in roughly nine teeth per child.

Moreover, dental caries is mostly caused by cariogenic bacterial infections. *Streptococcus mutans* (*S. mutans*) is the main cariogenic bacterium in the pathogenesis process of caries.3 *Streptococcus sobrinus* (*S. sobrinus*) is also thought to play a role in the production of caries.4 The pathogenesis process for dental caries involving *S. mutans* usually starts with bacterial colonisation. *S. mutans* biofilm then produces
organic acids as a by-product of fermentable carbohydrate metabolism. This acid can cause the local pH to fall below the critical value, resulting in the demineralisation of dental tissue. One of the results of S. mutans producing high cariogenicity levels is its ability to adhere to the surface of a tooth. This attachment is successfully performed by extracellular polysaccharides (EPS) derived from sucrose. This process also involves the microbiological characteristics of the bacterial cell wall structure.3

In most cases, S. mutans is the main cause of caries. Nevertheless, the role of acidogenic and other aciduric bacteria, such as S. sobrinus, is also assumed to be important. Based on several epidemiological and in vitro studies, S. sobrinus can be more cariogenic than S. mutans.6 The virulence of the S. mutans group is related to its ability to colonise and develop on the tooth surface during acidic conditions. These properties include the production and regulation of adhesion proteins, glucosyltransferases (GTF), and extracellular polysaccharides, such as glucans which allow bacteria to attach firmly to the surface of teeth in biofilms. The two species (S. sobrinus and S. mutans), however, have different strategies in their attachment mechanism. S. mutans uses pellicles and specific surface antigens directly, while S. sobrinus uses glucans.7

Previous research in Mongolia also showed that children aged between five and seven with both S. mutans and S. sobrinus in their saliva had significantly more dental caries than those who had only S. mutans or S. sobrinus.8 In test animals, S. sobrinus can produce more acids than other species in the S. mutans group. The prevalence and level of S. mutans and S. sobrinus colonies, as a result, have been used as biological markers for caries prediction.9 This study aims to analyse the distribution of S. mutans and S. sobrinus in children with severe levels of dental caries.

MATERIALS AND METHODS

This study was approved by the ethics committee number: 328/HRECC.FODM/VI/2019 of the Faculty of Dental Medicine, Universitas Airlangga. This study was an observational analysis research. Samples were collected October 2nd-10th, 2019. The Dental and Oral Hospital, Faculty of Dental Medicine, Universitas Airlangga, Surabaya, supplied samples from 50 paediatric patients. The patients were aged 6-12 years. Parents of these paediatric patients signed informed consent. The teeth examined were deciduous molars. The types of caries examined were superficial caries or caries media. Next, the severity of the caries was analysed based on decayed exfoliated filling teeth (DEFT) and the Simplified Oral Hygiene Index (OHI-S). S. mutans and S. sobrinus were then identified with multiplex polymerase chain reaction (PCR).

The caries lesions were taken from the first molar teeth using a sterile excavator and placed directly into the bottom of a tube containing Brain Heart Infusion Broth (BHI-B) (Merck, Darmstadt, Germany). Next, the tube was put into an incubator at 37°C for 24 hours. On the second day, the lesion was sub-cultured on selective Tryptone Yeast Cystine Sucrose Bactracin (TYCSB) (Himedia, Himedia Laboratories Pvt Ltd, India), and then incubated for two days. The growth of the colonies was indicated by the macroscopic characteristics of the colony of S. mutans, such as the hardened and sticky crystal form on the media, which were then examined with PCR.

The PCR multiplex method was used to detect S. mutans and S. sobrinus bacteria. The results of the amplification were then visualised using an electrophoresis method. DNA extraction was performed using the boiling method in TE buffer. A suspected three to five colonies on TYCSB media were taken and inoculated in Eppendorf tubes containing 100 μL of TE buffer, and homogenised by vortex mixer. The suspension was heated at a thermostat temperature of 95°C for ten minutes (Eppendorf, North America). After the samples reached room temperature, they were centrifuged at 10,000 rpm for ten minutes. The extracted DNA in the supernatant was stored at -20°C before use as the DNA template for PCR.10

PCR was run 25 μL PCR mixture, as follows: 12.5 μL of dNTPmix (Dream Taq Green, Thermo Scientific, USA), 0.5 μL (50pmol), 3.5 μL of bacterial DNA template, 1Ul tag pol, and then adding 17 μL of distilled water. The primers sequence of S. mutans used GTF-B F : ACT ACA TCT TGC GGT GCC TTGG as forward and GTF-B R : CAG TAT AAG CGC CAG TTT CACT as reverse in 517 bp.11 Primers sequence of S. sobrinus used GTF-I F : GAT AAC TAC CTG ACA GCT GAC T as forward and GTF-I R : AAG CTG CCT TAA GGT AAT CAC T as reverse in 712 bp.12 DNA amplification was then performed using a thermal cycler PCR machine (iCycler, Biorad Thermal Cycler).13

The PCR was first run using a hot initial temperature of 95°C for one minute and amplified for 35 cycles with denaturations at 94°C for 30 seconds, annealing at 53°C for one minute, elongation at 72°C for two minutes, and ending at 72°C for seven minutes. PCR results were visualised using electrophoresis in 2% agarose gel (Spectronics Corporation, USA), with 100 bp marker ladder. Electrophoresis was run at 100 volts for 30 minutes. Next, the agarose gel was stained with Ethidium bromide solution for 20 minutes. The amplicons were visualised using GelDoc (Digibox 7000, Mbiotech, Korea). Positive results were shown by the presenting of amplicon 517 bp for S. mutans and 712 bp for S. sobrinus. The results were studied using descriptive analysis of the distribution of S. mutans and S. sobrinus with caries severity, and then statistically analysed with the Chi-square test.

RESULTS

After conducting research, bacterial isolates obtained in this study were identified by multiplex PCR to confirm S. mutans and S. sobrinus (Figure 1). Figure 1 showed results of multiplex PCR positive S. mutans (GTF-B) in the
number 7038, 7039, 7040, 7041, 7042, 7043, 7044, 7045, 7046, 7048, 7049 and positive S. sobrinus (GTF-I) in the number 7039, 7043, 7048, 7049. The results were then grouped based on DEFT severity and OHI-S, then analysed by frequency distribution and Chi-square.

The prevalence of the colonisation of S. mutans was higher compared to S. sobrinus, 94% vs 30% (Table 1).

Based on the level of caries using DEFT scores, severe scores for S. mutans were higher than mild scores. Statistically, there was no significant difference using the Chi-square test (p value >0.05). As with S. mutans, S. sobrinus was higher in severe scores than mild scores of DEFT, but statistically, there was no significant difference. Based on OHI-S scores, S. mutans good scores were higher than bad scores. Statistical tests using Chi-square showed there was no significant difference (p value >0.05). As with S. mutans, the good DEFT S. sobrinus scores were higher than the mild scores, but again, statistically, there was no significant difference.

**DISCUSSION**

Several studies have shown that preventive efforts are effective in deterring early S. mutans colonisation from causing dental caries in children.\(^5\) Hence, this study aims to reveal the incidence pattern of S. mutans and S. sobrinus in children based on the DEFT and OHI-S. Next, the results of this study found that the highest incidence of bacteria causing dental caries was S. mutans (94%). Meanwhile, the incidence of S. sobrinus was 30%. These findings indicate the existence of S. mutans is considered not only as a microflora of the oral cavity but also as a pathogenic bacterium causing caries. Both S. mutans and S. sobrinus can proliferate in dental biofilm plaque. Their virulence is mainly due to their high adhesion ability, acidity, and their properties.

Moreover, dental biofilm containing cariogenic bacteria (caries-related micro-organisms) is one of the most harmful factors associated with the development of tooth decay. Dental biofilms can be found on hard surfaces in the oral cavity, such as on surfaces, implants, orthodontic devices, or restorative materials. The development of biofilm processes involves several progressive stages. The formation of initial biofilm accumulation involves specific processes. Variations in the biofilm coat in the oral cavity have a significant impact on oral ecology and dental caries development.\(^14\)

The higher colonisation rate of S. mutans and S. sobrinus, as demonstrated in this study would be ruled

---

**Table 1.** The isolation rate of S. mutans and S. sobrinus among children (n=50) with various dental caries severity level from patients visiting Dental and Oral Hospital Universitas Airlangga

| Severity Level | Children with dental caries (n=50) |  |
|----------------|------------------------------------|---|
| DEFT           | S. mutans (n=47=94%) p value       | S. sobrinus (n=15=30%) p value |
| Mild           | 12 (24%)                           | 3 (6%)                          | 0.124                          | 0.409                          |
| Severe         | 35 (70%)                           | 12 (24%)                        |                               |                                |
| OHI-S          | Good (n=70%)                        | 9 (18%)                         | 0.315                          | 0.083                          |
|                | Bad (n=24%)                         | 6 (12%)                         |                               |                                |

---

**Figure 1.** The results of multiplex PCR on S. mutans (GTF-B) and S. sobrinus (GTF-I).
by antigen I/II protein that strengthens the adherence to the tooth surface. It was also facilitated by glycoprotein receptors present in saliva, called salivary agglutinin. The other factors are cell-to-cell adherence and development of cohesive and pathogenic biofilms via the expression of GTFs. These enzymes (140 to 160 kDa) produce extracellular adhesive glucans that vary in chain length, contain α-1,3 and α-1,6 glucosyl linkages, and have a degree of branching and solubility. S. mutans comprises three genes for GTF: GTF-B, responsible for insoluble glucan synthesis; GTF-C, for soluble and insoluble glucan synthesis; and GTF-D, for soluble glucan synthesis. S. sobrinus expresses GTF-I and GTF-S, encoding enzymes that produce insoluble and soluble glucans, respectively. The prevalence of S. mutans and S. sobrinus is widely associated with caries. In several epidemiological studies, there was a correlation between the existence of S. sobrinus and the high incidence of dental caries.

The results of this study show that there was no statistically significant difference in the incidence of S. mutans and S. sobrinus between the high and low caries severity level. This can be caused by several factors, such as host factors, bacterial virulence, diet, environment, and time. Risk factors, such as sociodemographic factors, socioeconomic factors, knowledge levels, as well as behaviour, also affect the incidence of caries.

Dental caries occurs because of an imbalance between demineralisation and remineralisation. When demineralisation is higher than remineralisation, caries can occur. Oral hygiene also has a role in this balance. Nevertheless, in this study, there was no significant difference in the incidence pattern of S. mutans, S. sobrinus based on high or low DEFT and OHI-S.

Finally, this study interestingly reveals that there was no significant difference in the incidence pattern of S. mutans and S. sobrinus bacteria based on the severity of caries and OHI-S. This means that although these two bacteria are considered the main factors that cause dental caries, other factors may have an equally important role in caries. Hence, further research is expected to focus on more in-depth studies of S. mutans and S. sobrinus bacteria with other risk factors. In conclusion, this study showed that among carious teeth, 94% were colonised by S. mutans, and 30% of cases demonstrated co-colonisation of S. mutans and S. sobrinus. There were no significant differences in these bacterial colonisations between various levels of dental caries.

REFERENCES

1. Esberg A, Sheng N, Märel L, Claesson R, Persson K, Borén T, Strömberg N. Streptococcus mutans adhesin biotypes that match and predict individual caries development. EBioMedicine. 2017; 24: 205–15.
2. Badan Penelitian dan Pengembangan Kesehatan. Hasil Utama Risikesdas 2018. Jakarta: Kementerian Kesehatan Republik Indonesia; 2018. p. 66–71.
3. Shimomura-Kuroki J, Nashida T, Miyagawa Y, Sekimoto T. The role of genetic factors in the outbreak mechanism of dental caries. J Clin Pediatr Dent. 2018; 42(1): 32–6.
4. Fontana M, Zero DT. Assessing patients’ caries risk. J Am Dent Assoc. 2006; 137(9): 1231–9.
5. Selwitz RH, Ismail AI, Pitts NB. Dental caries. Lancet. 2007; 369(9555): 51–9.
6. Okada M, Taniguchi Y, Hayashi F, Doi T, Suzuki J, Sugai M, Kozai K. Late established mutans Streptococci in children over 3 years old. Int J Dent. 2010: 2010: 1–5.
7. Conrads G, de Soet JJ, Song L, Henne K, Szajer H, Wagner-Döbler I, Zeng AP. Comparing the cariogenic species Streptococcus sobrinus and S. mutans on whole genome level. J Oral Microbiol. 2014; 6(1): 1–13.
8. Soyolmaa M, Munguntsogt L, Shankhu MO, Hulanl U, Nishino M. PCR detection of Streptococcus mutans and Streptococcus sobrinus in plaque samples from Mongolian mother-child pairs. Pediatr Dent J. 2011; 21(2): 154–9.
9. Li Y, Caufield PW, Redmo Emanuelsson I, Thornerqvist E. Differentiation of Streptococcus mutans and Streptococcus sobrinus via genotypic and phenotypic profiles from three different populations. Oral Microbiol Immunol. 2001; 16(1): 16–23.
10. Kuntaman K., Hadi U, Setiawan F, Koendori EB, Rusli M, Santosaningsih D, Severin J, Verbrugh HA. Prevalence of meticillin resistant staphylococcus aureus from nose and throat of patients on admission to medical wards of Dr Soetomo hospital, Surabaya, Indonesia. Southeast Asian J Trop Med Public Health. 2016; 47(1): 66–70.

11. Widyagarini A, Sutadi H, Budiardjo SB. Serotype c and e streptococcus mutans from dental plaque of child-mother pairs with dental caries. J Int Dent Med Res. 2016; 9(Specialissue): 339–44.
12. Oho T, Yamashita Y, Shimazaki Y, Kusiyama M, Koga T. Simple and rapid detection of Streptococcus mutans and Streptococcus sobrinus in human saliva by polymerase chain reaction. Oral Microbiol Immunol. 2000; 15(4): 258–62.
13. Hakimi Alni R, Mohammadzadeh A, Mahmoodi P, Alikhani MY. Detection of toxic shock syndrome (tsst) gene among Staphylococcus aureus isolated from patients and healthy carriers. Avicenna J Clin Microbiol Infect. 2018; 5(1): 1–5.
14. Steinberg D, Eyal S. Early formation of Streptococcus sobrinus biofilm on various dental restorative materials. J Dent. 2002, 30(1): 47–51.
15. Lamont RJ, Hajishengallis GN, Jenkinson HF. Oral Microbiology and Immunology, 2nd ed. Washington: ASM; 2013, p. 242, 403.
16. Okada M, Soda Y, Hayashi F, Doi T, Suzuki J. PCR detection of Streptococcus mutans and S. sobrinus in dental plaque samples from Japanese pre-school children. J Med Micro. 2002; 51(5): 443–7.
17. Koch G, Poulc R. Pediatric dentistry: a clinical approach. 2nd ed. London: Wiley-Blackwell; 2013, p. 105.