Pesquisa Brasileira em Odontopediatria e Clínica Integrada 2022; 22:e210117
https://doi.org/10.1590/pboci.2022.029
ISSN 1519-0501 / eISSN 1983-4632

ORIGINAL ARTICLE

# The Clinical Pattern and Prevalence of *Streptococcus mutans* and *Streptococcus sobrinus* among Adult and Children Patients with Dental Caries

Nanik Zubaidah[1,2], Nur Dianawati[3], Rini Devijanti Ridwan[4], Toshiro Shirakawa[5], Kuntaman Kuntaman[6,7], Ernie Maduratna Setiawatie[8], Muhammad Iqbal Tanzil[9], Sri Kunarti[1]

[1]Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Indonesia.
[2]Doctoral Program of Medical Science, Faculty of Medicine, Universitas Airlangga, Indonesia
[3]Department of Oral Biology, Faculty of Dental Medicine, Institute of Health Science Bhakti Wiyata Kediri, Kota Kediri, Indonesia.
[4]Department of Oral Biology, Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Indonesia.
[5]Division of Translational Research for Biologics, Department of Internal Related, School of Medicine, Kobe University, Kobe, Japan.
[6]Department of Medical Microbiology, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia.
[7]Institute of Tropical Disease, Universitas Airlangga, Surabaya, Indonesia.
[8]Department of Periodontology, Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Indonesia.
[9]Conservative Dentistry Specialist Program, Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Indonesia.

**Correspondence:** Sri Kunarti, Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga Jalan Mayjend Prof. Dr. Moestopo no 47, Surabaya, Indonesia, 60132. **E-mail:** sri-k@fkg.unair.ac.id

**Academic Editor:** Catarina Ribeiro Barros de Alencar

**Received:** 17 Junho 2021 / **Review:** 29 September 2021 / **Accepted:** 15 November 2021

**How to cite:** Zubaidah N, Dianawati N, Ridwan RD, Shirakawa T, Kuntaman K, Setiawatie EM, et al. The clinical pattern and prevalence of *Streptococcus mutans* and *Streptococcus sobrinus* among adult and children patients with dental caries. Pesqui Bras Odontopediatria Clín Integr. 2022; 22:e210117. https://doi.org/10.1590/pboci.2022.029

**ABSTRACT**

**Objective:** To explore the clinical pattern, host factors, and presentation of *Streptococcus mutans* related to caries incidence among children and adults visiting Universitas Airlangga dental clinic. **Material and Methods:** This was an observational study with a cross-sectional approach with 50 patients in each group of carious children (6-12 years) and adults (18-35 years). Dental decay samples were taken by sterile excavator, put in a BHI's transport medium, and directly incubated overnight at 37 °C. The next day, they were sub-cultured microbiologically in Tryptone Yeast Cystine Sucrose Bacitracin (TYCSB) selective medium. Bacterial species and serogroups were examined by PCR. All patient's data were collected from medical records and direct observation. **Results:** Caries were mostly media type in both children and adults. Oral hygiene (OHIS) in children was higher than in adults but not significantly different according to their DMFT. The highest scores for decay, missed and filled teeth were 16, 8 and 7, with an average of 6.82, 1.22 and 0.63, considered quite high. **Conclusion:** The prevalence of *S. mutans* was higher in children's caries than in adults, but among the adult patients the co-incidence of *S. mutans* and *S. sobrinus* was associated with higher DMFT. The mutans serotypes e, f, and d were more prevalent among children than adults.

**Keywords:** Oral Health; Dental Caries; Oral Hygiene Index; DMF Index; *Streptococcus mutans*.

## Introduction

This study explored the clinical pattern, host factors, and presentation of mutans streptococci related to caries incidence among children and adults who visit the dental clinic at the Faculty of Dental Medicine, Universitas Airlangga Surabaya, Indonesia. Dental caries is the main cause of dental problems; it affects the dental surface and becomes an entry point that leads to endodontic infection. The two main bacteria that cause dental caries are *Streptococcus mutans* and *Streptococcus sobrinus* due to their aciduric and acidogenic capacity [1]. However, many other bacterial agents are also involved in caries development. An 16S-rRNA based study isolated six phylums and 22 bacterial species from white spots on children's teeth, but *Streptococcus mutans* and *Streptococcus sobrinus* were dominant [2]. This study also found that 25 among 36 children had white spots (69%), but only 11 (31%) had developed caries among healthy children.

National surveillance in Indonesia, known as Riskesdas (*Riset Kesehatan Dasar*) conducted by the Ministry of Health (MoH) in 2018, found that the prevalence of caries in Indonesian children aged 5-6 years was high, about 93% [3]. This was much higher than WHO targets for the year 2000, which were: 1) About 50% of 5-6 years old to be free of dental caries; 2) The global average to be no more than 3 DMFT at 12 years of age; 3) About 85% of the population should retain all their teeth at the age of 18 years; 4) A 50% reduction in edentulousness among adults 35-44 years old, compared with the 1982 level; and 5) A 25% reduction in edentulousness at the age of 65 years and over, compared with the 1982 level [4].

Caries or tooth decay are influenced by many factors, such as environment, behavior, lifestyle, poor oral hygiene, poverty, and others [5]. The colonization of acid-producing and fermentable carbohydrate bacteria has a pivotal role in developing tooth decay. It also attacks all ages, from toddlers to adults. A study in Riyadh, Kingdom of Saudi Arabia, in 2018, revealed that tooth decay was identified in 10.6% of 1844 primary school children 6-9 years old in First Permanent Molars (FPMs) [6]. A study of 442 medical and 359 dental undergraduate students in Russia showed the prevalence of DMFT > 0 was 96% and the mean DMFT index (Decayed, Missing or Filled Teeth) score of 7.58, meaning that decayed, missing or filled teeth per person averaged 7.58 teeth [7].

Many bacterial species are identified among carious teeth, including *Streptococcus mutans*, *Lactobacillus spp*, *Propionibacterium spp*, *Bifidobacterium dentium*, and *Veillonella spp*. [2,8], other studies have shown the dominance of *Streptococcus sobrinus* [9-12]. Subramaniam and Suresh [13] found that serotype c was more frequent than serotype e among *S. mutans*. In children 12 to 15 years old, the streptococcus-free group had a lower incidence of caries than the streptococcus-colonized group, and also, the group colonized with *S. mutans* only had a higher caries rate than the group colonized with *S. mutans* and *S. sobrinus* [12]. Other studies have shown the similarity of *S. mutans* and *S. sobrinus* in developing dental caries [1]. The serogroups of *S. mutans* are c, e or f, whereas *Streptococcus sobrinus* is included in serogroup d or g [14]. The study of cariogenicity in rats showed that fresh isolates of *S. sobrinus* were more cariogenic than *S. mutans* [15].

## Material and Methods

Ethical Clearance

This study was conducted in accordance with previous studies and was approved by the research committee, Faculty of Dental Medicine, Universitas Airlangga, with an ethical clearance of 328/ HRECC.FODM/VI/2019 [16]. Informed consent from all patients (or their parents or guardian for pediatric patients) were obtained.

Study Design

The study utilized a cross-sectional design to explore the relation of carious patterns with demography, clinical patterns, habit of sticky food consumption and the serogroup of bacteria harbored in tooth decay. The study was conducted from October 2019 to December 2019 in the Dental Hospital, Faculty of Dental Medicine, Universitas Airlangga.

Sampling and Data Collection

The inclusion criteria were all patients that visited the Universitas Airlangga Dental Clinic, pediatric or adult, with complaints of dental caries. The severity of the caries was categorized as superficial, media and profunda [17], and the clinical patterns were indicated by DMFT (Decayed, Missing/Extracted, and Filled Teeth) and OHIS (Oral Hygiene Index Simplified) [18,19]. There was also the educational status of the child patient's parent, which was classified into elementary school, high school, and university, and a habit of sticky food consumption was also observed.

Dental decay samples were taken by sterile excavator and put in a transport medium of Brain Heart Infusion broth (BHI) (Merck KGaA, Darmstadt, Germany) and incubated at 37 ºC overnight. The next day, samples were sub-cultured on a selected medium, Tryptone Yeast Cystine Sucrose Bacitracin (TYCSB) (Himedia Laboratories Pvt Ltd, India) and incubated at 37 ºC for 2 days [20-22]. The growth colonies were characterized macroscopically and suspected mutans groups with a hardened and sticky crystal appearance were then scrubbed, using a sterile inoculating needle to collect samples for PCR to identify the bacterial and serogroups of mutans streptococci [11,12,23]. The primers shown in Table 1 were used to identify serogroup mutans streptococci [14,24,25].

**Table 1. Primers for identification and serotyping of *S. mutans* and *S. Sobrinus*.**

| Species/Serotype | Primer (5'-3') | PCR product (bp/base pair) |
|---|---|---|
| *S. mutans* | GTF-B F: ACT ACA CTT TGC GGT GGC TTGG<br>GTF-B R: CAG TAT AAG CGC CAG TTT CACT | 517 bp |
| Serotype c (*S. mutans*) | SC-F: CGG AGT GCT TTT TAC AAG TGC TGG<br>SC-R: AAC CAC GGC CAG CAA ACC CTTT AT | 727 bp |
| Serotype e (*S. mutans*) | SE-F CCT GCT TTT CAA GTA CCT TTC GCC<br>SE-R: CTG CTT GCC AAG CCC TAC TAG AAA | 527 bp |
| Serotype f (*S. mutans*) | SF-F: CCC ACA ATT GGC TTC AAG AGG AGA<br>SF-R: TGC GAA ACC ATA AGC ATA GCG AGG | 316 bp |
| Serotype d (*S. sobrinus*) | GTF-I F: GAT AAC TAC CTG ACA GCT GACT<br>GTF-I R: AAG CTG CCT TAA GGT AAT CACT | 712 bp |

The species of *S. mutans*, *S. sobrinus* and serogroups were determined using multiplex PCR. DNA extraction was conducted by the boiling method using a common protocol [26,27]. Three to five suspected colonies were picked up from TYCSB medium, inoculated in 100 ul of TE buffer in an Eppendorf tube, and homogenized by vortex mixer. The suspension was heated at 95 ºC for 10 minutes by Thermostat (Eppendorf, North America). The suspension was then allowed to reach room temperature and centrifuged at 10,000 rpm for 10 minutes. The supernatant was collected as extracted DNA and stored at -20 until used as a template for PCR.

For PCR, *S. mutans* and *S. sobrinus* were run in a 25 µL PCR mixture of 12.5 µL of dNTPmix plus enzyme (Go Taq$^R$ Green Master Mix, Promega Corp., Madison, Wisconsin, USA), 0.5 µL each of 4 Primers (GTF-B & GTF-I), 5 µL of bacterial DNA template and 5.5 µL of nuclease free water. DNA amplification was

run in a thermal cycler PCR machine (T100 Thermal Cycler, Bio-Rad Laboratories, Hercules, CA, USA) at a hot start 95 ºC for 1 minute and 35 cycles with denaturation at 94 ºC, 30 seconds, annealing at 57 ºC, 1 minute, elongation at 72 ºC, 2 minutes, and then termination at 72 ºC for 7 minutes. The PCR product for *S. mutans* was 517 bp, and *S. sobrinus* (also found as serogroup d) was 712 bp.

For serogroups c, e, and f, PCR was run in 25 µL PCR mixture consisting of 12.5 µL of dNTP mix plus enzyme (Go Taq$^R$ Green Master Mix, Promega Corp., Madison, Wisconsin, USA), 0.4 µL each of 6 primers (total primers SC, SE, SF = 2.4 uL), 3 µL of (suspected *S. mutans* or *S. sobrinus* colonies) DNA template and 7.1 µL of nuclease free water. DNA amplification was then run in the same thermal cycler PCR machine, at hot start 95 ºC for 1 minute and 30 cycles with denaturation at 95 ºC, 30 seconds, annealing at 59 ºC, 30 seconds, elongation at 72 ºC, 30 seconds and then termination at 72 ºC for 4 minutes. The amplicons of mutans serogroups c, e, and f were 727 bp, 527 bp, and 316 bp, respectively.

PCR products were visualized by electrophoresis in 2% agarose gel (Spectronics Corporation, Melville, NY, USA) with marker Ladder 100 bp. Electrophoresis was run at 100 volts for 30 minutes (Mupid-2 Plus) and then stained with ethidium bromide for 20 minutes. The amplicons were visualized using Transilluminator *Spectroline* and photographed using Digibox7000 (Mbiotech, Seoul, South Korea).

Patient demographic data, clinical data on caries, oral hygiene and the pattern of DMFT were input in case record form (CRF) specific for this study, conducted by extracting the medical record and by direct observation of the patients.

Data Analysis

Data were entered and analyzed in SPSS software, version 25 (IBM Corp., Armonk, NY, USA). Data were expressed as means ± standard deviations (SD). The statistical analyses were performed with Chi-square or Fisher's exact. All statistical analyses used independent bacterial isolates or patients and two-tailed tests with p values < 0.05 were considered significant. The limitation of this study was not including the normal or not having dental decay as a control group in both children and adult patients.

## Results

A total of 100 samples were collected from 50 children 5-12 years old (30 female & 20 male) and 50 adults 18-35 years old (29 female & 21 male). There was no significant difference between groups in sex (p=0.50). Caries were mostly media type, 45 (90%) in children and 32 (64%) in adults. The superficial type was higher in adults (34%) than in children (6%), with a significant difference between children and adults (p<0.05) (Table 2).

**Table 2. The demographic data and pattern of oral hygiene, DMFT score and microbial inhabitant in decayed teeth among children and adults.**

| Variables | Children N (%) | Adult N (%) | p-value |
|---|---|---|---|
| Age (Mean and SD) | 7.82 (1.190) | 24.70 (5.651) | <0.01 |
| Sex | | | |
| Female | 30 (60.0) | 29 (58.0) | 0.50 |
| Male | 20 (40.0) | 21 (42.0) | |
| Caries Type | | | |
| Superficial | 3 (6.0) | 17 (34.0) | |
| Media | 45 (90.0) | 32 (64.0) | 0.002 |

| | | | |
|---|---|---|---|
| Profunda | 2 (4.0) | 1 (2.0) | |
| OHIS (Mean and SD) | 0.874 (0.5933) | 1.637 (1.0203) | <0.01[d] |
| Bad (≥1.255) | 12 (24.0) | 26 (52.0) | 0.004 |
| Good (<1.255) | 38 (76.0) | 24 (48.0) | |
| DMFT | | | |
| High (≥4.5) | 36 (72.0) | 34 (68.0) | 0.414 |
| Low (<4.5) | 14 (28.0) | 16 (32.0) | |
| D | 6.78 | 6.86 | 0.912 |
| M | 1.42 | 1.02 | 0.325 |
| F | 0.32 | 0.94 | 0.001 |
| *S. mutans* (n=73) | 47 (94.0)[b] | 26 (52.0)[c] | <0.01 |
| Serotype-c | 12 (24.0) | 9 (18.0) | 0.460 |
| Serotype-e | 15 (30.0) | 4 (8.0) | 0.005 |
| Serotype-f | 20 (40.0) | 3 (6.0) | <0.001 |
| Non-serogroup | 9 (18.0) | 12 (20.0) | |
| *S. sobrinus*[a] (n=21) | | | |
| Species or Serotype-d | 15 (30.0) | 6 (12.0) | 0.027 |

[a]Species *S. sobrinus* = serotype d; [b]One child had *S. mutans* c and e; 1 c and f; 3 e and f; and 2 c, e and f; [c]One adult had *S. mutans* c and e; [d]Mann-Whitney test.

*Streptococcus mutans* (*S. mutans*) and *Streptococcus sobrinus* (*S. sobrinus*) were significantly more prevalent in children than in adult patients, 94% *vs.* 52% for *S. mutans* (p=0.001) and 30% *vs.* 12% for *S. sobrinus* (p=0.027). Among 47 strains of *S. mutans*, clinical isolates in children, the serogroup of c, e, and f were 12 (24%), 15 (30%) and 20 (40%). One child co-harbored *S. mutans* c and e, 1 child c and f, 3 children e and f and 2 children c, e and f serotypes. Among 26 adults with *S. mutans*, the prevalence of serogroups c, e and f were 9 (18%), 4 (8%) and 3 (6%), respectively, and one adult co-harbored serotypes c and e. Nine *S. mutans* in children and 12 in adults were not identified in serogroups c, e, or f. The d serogroup of *S. sobrinus* was more common in children than adults, 15 (30%) *vs.* 6 (12%) (p=0.027) (Table 2 and Figure 1).

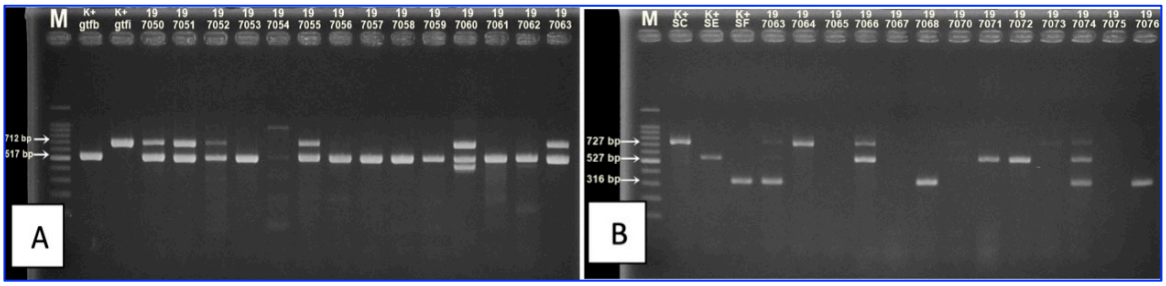


**Figure 1. Electrophoresis for identification of *S. mutans* (amplicon 517 bps) and *S. sobrinus* (712 bps) (A); and identification of serogroup c, e, and f of *S. mutans* (amplicon 727, 527, and 316 bp) (B).**

DMFT scores were similar between children and the adult group (p=0.414). In contrast, OHIS was significantly different (p=0.004), with the incidence of bad oral hygiene common in adults rather than in children (52% *vs.* 24%) (Table 3). The D, M, and F scores among children were 6.78, 1.42 and 0.32, respectively; *versus* 6.86, 1.02 and 0.94 in adults, showing no significant difference in DMFT between children and adults. *S. mutans* was more prevalent in high DMFT adult patients rather than in low DMFT, 22 (44%) *vs.* 4 (8%) (p=0.015). The distribution of serogroups c, e and f in both children and adults was not significantly different among any level of DMFT and OHIS (p>0.05) (Table 3).

**Table 3. The distribution of *S. mutans* and *S. sobrinus* serogroups among children and adult patients with varied DMFT and OHIS profiles.**

| Age Group / Microbials | DMFT | | | OHIS | | |
|---|---|---|---|---|---|---|
| | Low N (%) | High N (%) | p-value[c] | Good N (%) | Bad N (%) | p-value[c] |
| Children[a] | 14 (28.0) | 36 (72.0) | | 38 (76.0) | 12 (24.0) | |
| *S. mutans* (n=47) | 12 (24.0) | 35 (70.0) | 0.186 | 35 (70.0) | 12 (24.0) | 0.430 |
| Serotype-c | 3 (6.0) | 9 (18.0) | 1.000 | 9 (18.0) | 3 (6.0) | 1.000 |
| Serotype-e | 4 (8.0) | 11 (22.0) | 1.000 | 10 (20.0) | 5 (10.0) | 0.471 |
| Serotype-f | 6 (12.0) | 14 (28.0) | 1.000 | 16 (32.0) | 4 (8.0) | 0.740 |
| *S. sobrinus* Serotyped (n=15) | 3 (6.0) | 12 (24.0) | 0.507 | 9 (18.0) | 6 (12.0) | 0.146 |
| Adult[b] | 16 (32.0) | 34 (64.0) | | 24 (48.0) | 26 (52.0) | |
| *S. mutans* (n=26) | 4 (8.0) | 22 (44.0) | 0.015 | 12 (24.0) | 14 (28.0) | 0.430 |
| Serotype-c | 2 (4.0) | 7 (14.0) | 0.699 | 4 (8.0) | 5 (10.0) | 1.000 |
| Serotype-e | 1 (2.0) | 3 (6.0) | 1.000 | 2 (4.0) | 2 (4.0) | 0.471 |
| Serotype-f | 0 (0.0) | 3 (6.0) | 0.542 | 2 (4.0) | 1 (2.0) | 0.740 |
| *S. sobrinus* (n=6) (Serotype-d) | 1 (2.0) | 5 (10.0) | 0.650 | 2 (4.0) | 4 (8.0) | 0.146 |

[a]15 children and [b]4 adults had co-incident S. mutans and S. sobrinus; Significance level 5%, Chi-square.

There was also no significant difference in OHIS score based on the habit of sticky food consumption factors (p>0.05) (Table 4).

**Table 4. The distribution of DMFT among the children or adults with the habit of sticky/sweet food consumption or non-sticky food consumption.**

| Age's Group | Habit of Sticky Food Consumption | | p-value[1] |
|---|---|---|---|
| | Non-Sticky N (%) | Yes-Sticky N (%) | |
| Children | | | |
| DMFT[2] | | | |
| Low | 8 (57.1) | 6 (42.9) | 0.198 |
| High | 12 (33.3) | 24 (66.7) | |
| Total | 20 | 30 | |
| Adult | | | |
| DMFT | | | |
| Low | 8 (50.0) | 8 (50.0) | 0.543 |
| High | 13 (38.2) | 21 (61.8) | |
| Total | 21 | 29 | |
| Total DMFT | | | |
| Low | 16 (53.3) | 14 (46.7) | 0.123 |
| High | 25 (35.7) | 45 (64.3) | |
| Total | 41 | 59 | |
| Children | | | |
| OHIS[3] | | | |
| Good (<1.255) | 17 (44.7) | 21 (55.3) | 0.317 |
| Bad (≥1.255) | 3 (25.0) | 9 (75.0) | |
| Total | | | |
| Adult | | | |
| OHIS | | | |
| Good (<1.255) | 11 (45.8) | 13 (54.2) | 0.775 |
| Bad (=≥1.255) | 10 (38.5) | 16 (61.5) | |
| Total | 21 | 29 | |
| Total | | | |
| OHIS | | | |
| Good (<1.255) | 28 (45.2) | 34 (54.8) | 0.303 |
| Bad (≥1.255) | 13 (34.2) | 25 (65.8) | |
| Total | 41 | 59 | |

[1]Significant if p<0.05; [2]DMFT = Decayed, Missing, and Filled Teeth; OHIS = Oral Hygiene Index Simplified.

There were no significant differences in dental caries type and OHIS in the high school versus university group (p>0.05), but it is a significant difference in the Elementary group (p<0.05). But all groups showed they were likely to have media caries. The university group showed there are more people with bad oral hygiene. There is no significant difference in DMFT among all groups (p>0.05), and all groups have a higher DMF-T (Table 5).

**Table 5. The pattern of caries type, OHIS and DMFT among patients according to education level**

| Variables | Elementary[c] N (%) | High School N (%) | University N (%) |
|---|---|---|---|
| Caries Type | | | |
| Superficial | 3 (6.0) | 12 (40.0) | 5 (25.0) |
| Media | 45 (90.0) | 17 (56.7) | 15 (75.0) |
| Profunda | 2 (4.0) | 1 (3.3) | 0 (0.0) |
| p-value[a] | | 0.399 | |
| | | 0.005 | |
| OHIS | | | |
| Bad (≥1.255) | 12 (24.0) | 14 (46.7.0) | 12 (60.0) |
| Good (<1.255) | 38 (76.0) | 16 (53.3.0) | 8 (40.0) |
| p-value[a] | | 0.352 | |
| | | 0.010 | |
| DMFT | | | |
| High (≥4.5) | 36 (72%) | 20 (62.7) | 14 (70.0) |
| Low (<4.5) | 14 (28%) | 10 (33.3) | 6 (30.0) |
| p-value[b] | | 1.000 | |
| | | 0.881 | |

[a]There was no significance between High School versus University (p=0.352), but significant versus Elementary school, and [b]There was no significance among education; [c]The limitation of this method was not included the education of the parent of the children/patients.

## Discussion

This study aimed to explore the clinical pattern, host factors and presentation of mutans streptococci related to caries incidence among children and adults visiting the dental clinic at the Faculty of Dental Medicine, Universitas Airlangga Surabaya. The two main bacterial presentations in dental caries are *Streptococcus mutans* and *Streptococcus sobrinus* due to their aciduric and acidogenic capacity. *S. mutans* and *S. sobrinus* were frequently found in children patients. Among 47 strains of *S. mutans*, clinical isolates in children, the serogroup of c, e, and f were 12 (24%), 15 (30%) and 20 (40%). Among 26 adults with *S. mutans*, the prevalence of serogroups c, e and f was 9 (18%), 4 (8%) and 3 (6%), respectively. The d serogroup of *S. sobrinus* was more common in children. In contrast, *S. mutans* was more prevalent in high DMFT among adult patients.

Most of the 100 patients who visited the dental clinic, most had caries media (77%). There was no significant difference in sex, type of caries and DMFT between children and adults. Patients who visited the dental clinic suffering from dental pain were similar between children and adult groups, about 5 (10%). These patients indicated the involvement of dental pulp, due to deep caries. About 10% of patients with caries came late to seek treatment and needed endodontic procedures. Kamran et al. [28] showed that untreated dental decay or dental caries reach the pulp and become an endodontic problem requiring treatment to reserve their teeth.

According to the level of DMFT, the D, M and F average scores in this study were 6.82, 1.22 and 0.63, and the maximum D, M and F scores were 16, 8 and 7, respectively. The averages of D and M score in children and adults were 6.78 *vs.* 6.86 and 1.42 *vs.* 1.02 (p>0.05), whereas the F score was 0.32 *vs.* 0.94 (p<0.05). The D score was very high. This pattern was different from the study of Kamran et al., with an average D, M

and F in permanent dentition of 0.83, 0.16 and 0.006 [28]. The caries level in the Indonesian population seems more severe. The limitation of our study was including the patients who were visiting the dental clinic for taking the dental care, and thus will not be able to predict the population in general in the community. One of the limitations of our study was not including caries-free individuals and future studies should include them to strengthen their analyses. The F (filled teeth) score of adult patients was significantly higher than in children ($p<0.05$), possibly due to awareness and aesthetic issues among adults, male or female. The habit of sticky food consumption (consuming sticky and sweet food) was more prevalent in children than adults ($p=0.028$), 38 (76%) *vs.* 28 (56%), but there was no significant impact on DMFT in children, adults or both in combination ($p>0.05$). The quantity of sticky and sweet consumption would be a factor affecting these differences.

The children had high DMFT (72%) rather than low DMFT (28%), showing that dental health education should be conducted intensively to prevent late stage caries. The superficial caries type was more prevalent in adults, whereas the media type was more prevalent in children. This condition could be understood as due to the higher awareness of adult patients seeking the dental clinic early, while children require their families to become aware of the problem. Interestingly, the OHIS among children was better than adults ($p<0.05$). Page et al. [29] showed that the risk of periodontitis increases with age among adults. Therefore, even though not fully correlated, one would expect the OHIS to worsen at older ages.

Our present study found no significant difference in education (High School and University level in adults) in caries type and OHIS, but it showed a significant difference versus the children group that all sit in elementary school. There were no significant differences in DMFT scores among the patients' educational backgrounds (Table 5). A limitation of our study was not including any data regarding the parents or families of patients' educational backgrounds, as shown in the study Mulu et al. [30]. The study of Mulu et al. in Bahir Dar City, Ethiopia, found that among 32 (21.77%) of 147 children with caries, caries significantly correlated with family educational status [30]. Caries type in our study was not associated with consuming sweet or sticky food (Table 4), again unlike the study of Mulu et al. [30] in caries presentation, but that study did not include information about caries severity. In our study, *S. mutans* was more prevalent in higher DMFT among adult patients ($p<0.05$) but not in children. It correlated with OHIS, worse in adults than in children ($p<0.05$) (Table 2). Other studies in children also showed that older age correlated with higher *S. mutans* and *S. sobrinus* colonization and higher dmft (deciduous) [23]. The colonization rate of *S. mutans* and *S. sobrinus* is fostered by antigen I/II protein that strengthens adherence to the tooth surface and is also facilitated by a glycoprotein receptor present in saliva known as salivary agglutinin [31,32].

The co-incidence of *S. mutans* and *S. sobrinus* resulted in significantly higher DMFT for adults but not for children, compared to the single presentation of *S. mutans* or *S. sobrinus* ($p=0.038$). Another study showed that among 303 12-year-old children, DMFT was higher in the group colonized with *S. mutants* only, whereas among 311 15-year-old children, children co-colonized with *S. mutants* and *S. sobrinus* had the highest DMFT (3.71), followed by the group with *S. mutants* only (DMFT=3.08), the much lower group with *S. sobrinus* only (DMFT=2.20), and the group free of *S. mutants/S. sobrinus* (DMFT=1.36), respectively [12]. At higher ages, the co-presentation of *S. mutants* and *S. sobrinus* is associated with higher DMFT. Our present study found a significantly higher prevalence of mutans streptococci serogroups e, f and d in children compared to adult patients ($p<0.05$), but not serogroup c. Widyagarini et al. [11], in another Indonesian study, found that among 46 children 3-5 years old, the *S. mutans* serogroups c and e more frequently colonized dental plaque, 63.04% versus 21.74%. Three children (6.52%) had co-incidence of both serogroup c and e [11]. Serogroups e, f and d may have more impact on caries development compared to serogroup c, but further study is needed to explore

this finding. This difference between our findings and some other studies could be due to the population target, isolation technique and different identification. In addition, the difference in caries status and the type of caries lesion can also influence this difference. The study of Widyagarini et al. [11] in Jakarta (about 900 km from Surabaya) that isolated *S. mutans* serotype c and e from the community showed that *S. mutans* serotype c is more prevalent rather than serotype e, 63.04% versus 21.74%% in children, and 45.65% versus 19.57% in their mother. Our study showed that in children, the prevalence of *S. mutans* serogroup c, e and f were 24%, 30% and 40%, whereas among adults were 34.6%, 15.58% and 11.54%. It shows the increasing trend of serotype c against aged people.

The caries type among patients visiting the dental clinic was mostly media type in both children and adults. The OHIS in children was higher than in adults, but there was no significant difference according to their DMFT. The highest scores for decay, missing, and filled teeth were 16, 8, and 7, with an average of 6.82, 1.22 and 0.63, considered quite high.

## Conclusion

The prevalence of *S. mutans* was higher in children's caries than in adults, but among the adult patients, the co-incidence of *S. mutans* and *S. sobrinus* were more prevalent on higher DMFT rather than single presentation. In addition, the mutans serogroups e, f, and d were more prevalent among caries in children than adults.

## Authors' Contributions


| | | |
|---|---|---|
| NZ | https://orcid.org/0000-0002-3205-6071 | Conceptualization, Methodology, Formal Analysis, Data Curation, Writing - Original Draft and Writing - Review and Editing. |
| ND | https://orcid.org/0000-0002-9258-5792 | Investigation, Data Curation and Writing - Review and Editing. |
| RDR | https://orcid.org/0000-0002-0090-9746 | Validation, Formal Analysis and Data Curation. |
| TS | https://orcid.org/0000-0003-3925-8730 | Conceptualization, Methodology, Validation, Data Curation and Writing - Review and Editing. |
| KK | https://orcid.org/0000-0003-4897-8879 | Conceptualization, Methodology and Validation. |
| EMS | https://orcid.org/0000-0001-8262-974X | Validation, Formal Analysis and Data Curation. |
| MIT | https://orcid.org/0000-0001-8760-7136 | Methodology, Investigation and Writing - Review and Editing. |
| SK | https://orcid.org/0000-0003-2212-922X | Conceptualization, Methodology, Formal Analysis, Data Curation, Writing - Original Draft and Writing - Review and Editing. |

All authors declare that they contributed to critical review of intellectual content and approval of the final version to be published.


## Financial Support

This study was supported by a J-GRID grant from the Ministry of Education, Culture, Sports, Science, and Technology (Grant number 18fm0108004h0004) and a Tahir Professorship Grant from Airlangga University, Indonesia (Grant number 1149/UN3/2018).

## Conflict of Interest

The authors declare no conflicts of interest.

## Data Availability

The data used to support the findings of this study can be made available upon request to the corresponding author.

## References


[1] Conrads G, de Soet JJ, Song L, Henne K, Sztajer H, Wagner-Döbler I, et al. Comparing the cariogenic species Streptococcus sobrinus and S. mutans on whole genome level. J Oral Microbiol 2014; 6:26189. https://doi.org/10.3402/jom.v6.26189

[2] Gross EL, Beall CJ, Kutsch SR, Firestone ND, Leys EJ, Griffen AL. Beyond Streptococcus mutans: Dental Caries Onset Linked to Multiple Species by 16S rRNA Community Analysis. PLoS One 2012; 7(10):e47722. https://doi.org/10.1371/journal.pone.0047722

[3] Kemenkes RI. Laporan Nasional Riset Kesehatan Dasar. Kementeri. Kesehat Republok Indonesia; 2018. 582p. [In Indonesian].

[4] WHO Oral Health Programme. Global data on dental caries prevalence (DMFT) in children aged 12 years. Global Oral Data Bank, Oral Health/Area Profile Programme. World Health Organization. https://apps.who.int/iris/handle/10665/66520

[5] Selwitz RH, Ismail AI, Pitts NB. Dental caries. Lancet 2007; 369(9555):51-9. https://doi.org/10.1016/S0140-6736(07)60031-2

[6] S Aldossary M, A Alamri A, A Alshiha S, A Hattan M, K Alfraih Y, M Alwayli H. Prevalence of dental caries and fissure sealants in the first permanent molars among male children in Riyadh, Kingdom of Saudi Arabia. Int J Clin Pediatr Dent 2018; 11(5):365-70. https://doi.org/10.5005/jp-journals-10005-1541

[7] Drachev SN, Brenn T, Trovik TA. Dental caries experience and determinants in young adults of the Northern State Medical University, Arkhangelsk, North-West Russia: a cross-sectional study. BMC Oral Health 2017; 17(1):136. https://doi.org/10.1186/s12903-017-0426-x

[8] Aas JA, Griffen AL, Dardis SR, Lee AM, Olsen I, Dewhirst FE, et al. Bacteria of dental caries in primary and permanent teeth in children and young adults. J Clin Microbiol 2008; 46(4):1407-17. https://doi.org/10.1128/JCM.01410-07

[9] Ouhara K, Komatsuzawa H, Yamada S, Shiba H, Fujiwara T, Ohara M, et al. Susceptibilities of periodontopathogenic and cariogenic bacteria to antibacterial peptides, {beta}-defensins and LL37, produced by human epithelial cells. J Antimicrob Chemother 2005; 55(6):888-96. https://doi.org/10.1093/jac/dki103

[10] Steinberg D, Eyal S. Early formation of Streptococcus sobrinus biofilm on various dental restorative materials. J Dent 2002; 30(1):47-51. https://doi.org/10.1016/s0300-5712(01)00058-6

[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; 9:339-44.

[12] Sánchez-Acedo M, Montiel-Company JM, Dasí-Fernández F, Almerich-Silla JM. Streptococcus mutans and Streptococcus sobrinus detection by Polymerase Chain Reaction and their relation to dental caries in 12 and 15 year-old schoolchildren in Valencia (Spain). Med Oral Patol Oral Cir Bucal 2013; 18(6):e839-4. https://doi.org/10.4317/medoral.18941

[13] Subramaniam P, Suresh R. Streptococcus mutans strain in mother-child pairs of children with early childhool caries. J Clin Pediatr Dent 2019; 43(4):252-6. https://doi.org/10.17796/1053-4625-43.4.5

[14] Nakano K, Ooshima T. Serotype classification of Streptococcus mutans and its detection outside the oral cavity Kazuhiko. Futur Microbiol 2009; 4(7):891-902. https://doi.org/10.2217/fmb.09.64

[15] de Soet JJ, van Loveren C, Lammens AJ, Pavicić MJ, Homburg CH, ten Cate JM, et al. Differences in cariogenicity between fresh isolates of Streptococcus sobrinus and Streptococcus mutans. Caries Res 1991; 25(2):116-22. https://doi.org/10.1159/000261353

[16] Dianawati N, Setyarini W, Widjiastuti I, Ridwan RD, Kuntaman K. The distribution of Streptococcus mutans and Streptococcus sobrinus in children with dental caries severity level. Dent J (Majalah Kedokt. Gigi) 2020; 53(1):36. https://doi.org/10.20473/j.djmkg.v53.i1.p36–39

[17] Frese C, Wohlrab T, Sheng L, Kieser M, Krisam J, Frese F, et al. Clinical management and prevention of dental caries in athletes: A four-year randomized controlled clinical trial. Sci Rep 2018; 8(1):1-10. https://doi.org/10.1038/s41598-018-34777-x

[18] Shabani LF, Begzati A, Dragidella F, Hoxha VH, Cakolli VH, Bruçl B. The correlation between DMFT and OHI-S Index among 10-15 years old children in Kosova. J Dent Oral Heal 2015; 1(1):1-5. https://doi.org/10.13140/RG.2.1.2554.6087

[19] Asif SM, Naheeda S, Assiri KI, Almubarak HM, Kaleem SM, Zakirulla M, et al. Oral hygiene practice and periodontal status among two tribal population of Telangana state, India- an epidemiological study. BMC Oral Health 2019; 19(1):4-9. https://doi.org/10.1186/s12903-018-0705-1

[20] Wade WG, Aldred MJ, Walker DM. An improved medium for isolation of Streptococcus mutans. J Med Microbiol 1986; 22(4):319-23. https://doi.org/10.1099/00222615-22-4-319

[21] Wan AK, Seow WK, Walsh LJ, Bird PS. Comparison of five selective media for the growth and enumeration of Streptococcus mutans. Aust Dent J 2002; 47(1):21-6. https://doi.org/10.1111/j.1834-7819.2002.tb00298.x

[22] Momeni SS, Patrick P, Wiener HW, Cutter GR, Ruby JD, Cheon K, et al. Mutans streptococci enumeration and genotype selection using different bacitracin-containing media. J Microbiol Methods 2014; 103:53-7. https://doi.org/10.1016/j.mimet.2014.05.010

[23] Soyolmaa M, Munguntsetseg L, Sharkhuu MO, Nishino M, Hulan U. PCR detection of Streptococcus mutans and Streptococcus sobrinus in plaque samples from Mongolian mother-child pairs. Pediatr Dent J 2011; 21:154-9. https://doi.org/10.1016/S0917-2394(11)70242-7

[24] Nakano K, Nomura R, Ooshima T. Streptococcus mutans and cardiovascular diseases. Jpn Dent Sci Rev 2008; 44(1):29-37. https://doi.org/10.1016/j.jdsr.2007.09.001

[25] Oho T, Yamashita Y, Shimazaki Y, Kushiyama 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. https://doi.org/10.1034/j.1399-302x.2000.150408.x

[26] Saeed HM, Faraj BM, Mirdan BM. Evaluation of 5-aminolevulinic acids induced photodynamic inactivation on Streptococcus mutans and Streptococcus sobrinus; by using two light emitting diode wavelengths (in vitro study). Biomedical Research 2019; 30(5):727-32. https://doi.org/ 0.35841/biomedicalresearch.30-19-312

[27] Murakami K, Minamide W, Wada K, Nakamura E, Teraoka H, Watanabe S. Identification of methicillin-resistant strains of staphylococci by polymerase chain reaction. J Clin Microbiol 1991; 29(10):2240-4. https://doi.org/10.1128/jcm.29.10.2240-2244.1991

[28] Kamran R, Farooq W, Faisal MR, Jahangir F. Clinical consequences of untreated dental caries assessed using PUFA index and its covariates in children residing in orphanages of Pakistan. BMC Oral Health 2017; 17(1):108. https://doi.org/10.1186/s12903-017-0399-9

[29] Page RC, Martin JA, Loeb CF. The Oral Health Information Suite (OHIS): its use in the management of periodontal disease. J Dent Educ 2005; 69(5):509-20. https://doi.org/10.1002/j.0022-0337.2005.69.5.tb03939.x

[30] Mulu W, Demilie T, Yimer M, Meshesha K, Abera B. Dental caries and associated factors among primary school children in Bahir Dar city: a cross-sectional study. BMC Res Notes 2014; 7:949. https://doi.org/10.1186/1756-0500-7-949

[31] Manzer HS, Nobbs AH, Doran KS. The multifaceted nature of Streptococcal Antigen I/II proteins in colonization and disease pathogenesis. Front Microbiol 2020; 11:602305. https://doi.org/10.3389/fmicb.2020.602305

[32] Okada M, Soda Y, Hayashi F, Doi T, Suzuki J, Miura K, et al. PCR detection of Streptococcus mutans and S. sobrinus in dental plaque samples from Japanese pre-school children. J Med Microbiol 2002; 51(5):443-7. https://doi.org/10.1099/0022-1317-51-5-443