



## Association of smokeless tobacco with periodontal health of patients seeking treatment at a Dental Hospital setting in Sri Lanka

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### ABSTRACT

**Introduction:** Betel chewing has indeed been an integral part of many cultures in South Asia and beyond for centuries. The practice involves the combination of various ingredients, including areca nut (also known as betel nut), slaked lime, and often tobacco, all wrapped in a betel leaf. This mixture is chewed for its stimulating and psychoactive effects. In addition to its widespread cultural significance, betel chewing has been linked to social rituals, celebrations, and even medical practices in some regions. Despite its cultural importance, it's important to note the health concerns associated with betel chewing. The use of areca nut has been linked to an increased risk of oral cancers, gum disease, and other health issues. Some studies also indicate that the combination of areca nut and tobacco significantly raises the risk of developing these conditions.

**Main objective:** To assess any association of smokeless tobacco (SLT) with periodontal health of patients seeking dental treatment.

**Specific objectives:** To assess the association of periodontal status with oral hygiene habits of patients seeking dental treatment.

To assess the association between smokeless tobacco use with plaque score, bleeding score, BPE (Basic Periodontal Examination) scores and pocket depth measurements.

**Materials and method:** This was a cross sectional descriptive study, conducted among adult patients above the age of 18 years, randomly selected from the daily diagnostic clinic of the Dental (Teaching) Hospital, Peradeniya (DTHP), Sri Lanka. The sample size was calculated by using Lawanga and Lamshow sample size calculation method (Lwanga & Lemeshow, 1991) ensuring a 95 % confidence level and 80 % power and a systematic sampling technique. The study instrument was a check-list to obtain socio demographic information and periodontal health status.

**Results:** A total of 355 adult patients were included in the study, with a mean age of 38 (SD  $\pm$  15.2 years) and the age range between 18 and 75 years. Out of the total study sample, 120 (34 %) were male and 235 (66 %) were female.

It was identified that age is significantly associated with severe periodontal disease ( $p < 0.001$ , OR = 1.043 per year increase) and Plaque score percentile is a strong predictor ( $p < 0.001$ , OR = 1.87), indicating a higher plaque score is linked to severe periodontal destruction.

The inferential statistics revealed that there was a statistically significant increase in the plaque scores ( $P = 0.007$ ), bleeding scores ( $P = 0.007$ ) and BPE scores ( $P = 0.003$ ) in smokeless tobacco users when compared with those who do not use smokeless tobacco. Moreover, the periodontal pocket depths (PPD) of smokeless tobacco (SLT) users were significantly greater ( $P = 0.023$ ) than those of tobacco nonusers (NSLT). Among the SLT users, and those who had good oral health habits which was assessed in related to their brushing frequency, showed no significant association across their periodontal (PDD) pocket depths resembling their PDD health.

**Conclusion:** The results indicated that smokeless tobacco is detrimental to periodontal health. Habit intervention and reduction in the consumption of smokeless tobacco may significantly reduce periodontal disease, and therefore, these preventive measures should be encouraged in SLT users.

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## 1. Introduction

The habit of betel chewing is common and widespread in South Asian countries, and it has a great antiquity. Globally, it is the fourth most widely used psychoactive substance following caffeine, alcohol and tobacco which consists of a mixture of areca nuts (with or without tobacco), slaked lime, catechu and several condiments and sweeteners such as coconut according to taste, wrapped in betel leaf<sup>1,2</sup>.

Large-scale **epidemiological** and **experimental studies** have provided strong evidence linking the consumption of SLT with a variety of oral health issues and **systemic health risks**.<sup>3,4</sup> The **oral cavity** is particularly vulnerable, with SLT contributing to a range of diseases, from gum disease to cancers. Smokeless Tobacco has been classified as a group 1 human carcinogen by the World Health Organization (WHO) and International Research on Cancer<sup>5</sup> which has the capability to stimulate the cellular proliferation, synergistic effect on pathogenesis of Oral Submucous Fibrosis and Oral cancer. Several studies have demonstrated that areca extracts containing arecolin, inhibits protein synthesis, growth and attachment of periodontal fibroblasts. This in turn could exacerbate preexisting periodontal disease and loss of periodontal attachment. Periodontal pocketing and gingival recession have also been reported to be significantly greater in SLT users than those in non-users.<sup>6–9</sup>

However, the above findings may not provide conclusive evidence to build a relationship for the prevalence of periodontal diseases in SLT users and non-users, since there could be several confounding factors and other variables such as the level of oral hygiene, general health status, risk factors, dietary factors and tobacco smoking which are established factors affecting an individual's periodontal health.<sup>10</sup>

Since high rates of SLT usage have been reported in Sri Lanka previously and availability of less literature to identify the relation between SLT use and periodontal health, this study have been established to assess the association between smokeless tobacco use and plaque score, bleeding score, BPE scores and periodontal pocket depth in patients attending the University Dental Hospital, Peradeniya, Sri Lanka.

Research in Sri Lanka can also contribute to the global understanding of the health impacts of smokeless tobacco. It may offer comparative insights with other regions and help inform global health policy. The findings could be useful in advocating for international tobacco control efforts, which aim to reduce the global burden of tobacco-related diseases.

Therefore, conducting this research would not only address a significant gap in local health knowledge but also contribute to improving public health strategies, informing policy decisions, and potentially reducing the burden of periodontal disease in Sri Lanka and beyond.

## 2. Material and method

This research proposal was approved by the Ethical Review Committee (ERC/FDS/UOP/2020/35) Faculty of Dental Sciences, University of Peradeniya, Sri Lanka.

### 2.1. Main objective

To assess any association of smokeless tobacco with periodontal health of patients seeking dental treatment.

### 2.2. Specific objectives

To assess the association of periodontal status with oral hygiene habits of patients seeking dental treatment.

To assess the association between smokeless tobacco use with plaque score, bleeding score, BPE (Basic Periodontal Examination) scores and pocket depth measurements.

A cross sectional descriptive study was conducted among the patients aged between 18 and 75 years, attending the diagnostic clinic of the

Dental Teaching Hospital, Peradeniya (DTHP), Sri Lanka. The sample was ascertained from the first-visit patients who seek treatment from DTHP. The sample size of 355 patients was calculated using the Lwanga and Lemeshow (1991) formula, ensuring a 95 % confidence level and 80 % power. However, due to the real-world nature of the study setting, an exact 1:1 matching of SLT users and non-users was not feasible.

Almost all the patients were using the smokeless tobacco as part of the betel quid and those who were using other types of SLT/commercially prepared products were too small for any calculation. This observation in the study is in accordance with the general pattern of SLT use in Sri Lanka where commercially prepared products are only used by the younger group of people.

A systematic sampling technique was used in this study. The patients from the patient register were randomly selected by using random number tables.

The following subjects were included in the present study.

- Adults aged 18–75 years
- First-time visitors to the diagnostic clinic
- SLT users with a history of use for at least one year
- Non-users who have never used any form of tobacco
- Providing informed consent

These subjects were excluded from the study. This approach was used to prevent potential confounding factors.

- Patients with systemic conditions affecting periodontal health (e.g., diabetes, cardiovascular diseases, rheumatoid arthritis or any other disease requiring continuous medication and those with psychological impairment)
- Patients with a history of periodontal treatment within the past six months
- Current or former smokers of combustible tobacco
- Pregnant or lactating women
- Patients with extensive dental prostheses or missing more than 50 % of their natural dentition

Informed written consent was obtained from all study participants. The study instruments included a checklist, and a questionnaire designed to gather sociodemographic information and assess the oral health status of each participant. Information related to their oral hygiene habits, dietary habits and smokeless tobacco habits were also obtained. Oral examination was performed by the principal investigator (PI) to assess the dentition status according to the DMFT Index and periodontal parameters including Bleeding Score Percentile, Plaque Score Percentile and periodontal disease severity with measuring probing pocket depth (Oral Health Survey Basic Methods-World Health Organization). All clinical examinations were carried out under the standard infection control protocols.

The Basic Periodontal Examination (BPE) scores and bleeding scores were assessed by using a CPI/WHO probe (BPE by the British Society of Periodontology, 2019). The patients with BPE scores of 3 and 4, underwent a periodontal charting. Accordingly, six sites of tooth surfaces (mesiobuccal, buccal, distobuccal, distolingual, lingual and mesiolingual) were examined for each tooth for probing pocket depth. Moreover, the plaque and bleeding scores was recorded.

To determine the intraexaminer variability, every 5th patient of the selected sample was reexamined.

### 2.3. Data analysis

The data were analysed using SPSS version 27.0. Descriptive statistics with frequency distributions, mean, standard deviations, and chi square tests for inferential statistics were used for data analysis. Multinomial Logistic regression analysis was carried out to determine the independent effect of SLT use on periodontal status.

2.4. Results

A total of 355 adult patients were participated in the study, with a mean age of 38 years (SD ± 15.2) representing a total cohort of adults aged between 18 and 75 years. The study sample comprised 235 females and 120 males (66 % and 34 % respectively).

A majority of the study participants were from rural areas (approximately 72 %; n = 257), whereas 28 % (n = 98) of them were from the urban areas.

When oral hygiene habits were considered (Table 1), the frequency of tooth brushing in the total study sample was two or more than times a day (88 % and 74 % for female and male participants respectively). The use of fluoridated toothpaste for brushing was a common practice (81 % and 90 % for the female and male participants respectively). Notably, the use of interdental cleaning aids (IDCAs) was not frequent among the study participants, with only 6 % of females and 12 % of males using IDCAs.

It was noteworthy to consider that even with two or more than twice brushing frequencies per day and with using inter-dental cleaning aids, the study population had unsatisfactory periodontal health denoted by BPE codes 2,3 and 4. So statistical significance couldn't be identified among oral hygiene practices, brushing frequency (P = 0.029), and using interdental cleaning aids (P = 0.024) with BPE codes.

The habit of SLT use was noted as popular among both female and male participants (91 % and 62 % respectively).

Oral health status of the study participants was represented by the DMFT score, plaque score, bleeding score and BPE score. As there was a nonnormal distribution of DMFTs among the participants, the median of DMFT score of 6 was used to dichotomize the values. Participants who had a plaque score of less than 15 % were considered to have satisfactory control of the plaque. According to the findings, most of the participants (97 % females and 95 % males) had high plaque scores, therefore they were considered to have unsatisfactory plaque control. The bleeding scores of the participants also displayed a nonnormal distribution with a median value of 23.4. The distributions are illustrated in Fig. 1. Moreover, the BPE scores revealed that a majority of the participants needed some periodontal interventions such as oral hygiene instructions, scaling and root surface debridement.

A majority of the participants (76 %) also had deep periodontal pockets of 5–6 mm, whereas only 4 % were free of deep periodontal pockets as they demonstrated probing depths of less than 4 mm. The remaining participants presented with deep periodontal pockets of more than 7 mm (Fig. 2).

The findings of the present study demonstrated that plaque and

bleeding scores were significantly higher in SLT users (44 % and 53 % respectively) than in SLT nonusers (14 % and 14 % respectively). The inferential statistics revealed that there was a statistically significant positive association between SLT use and the plaque score (P = 0.007), bleeding score (P = 0.007) and BPE (P = 0.003) of the study participants. Moreover, periodontal pocket depth was significantly positively associated with the smokeless tobacco use (P = 0.023). The results are displayed in Table 2.

Among the SLT consumers who practised tooth brushing more than once per day (n = 261), 45 % (n = 117) had periodontal probing depths of less than 4 mm, whereas 55 % (n = 144) had pocket depths of more than 4 mm. However, the difference between the two groups was not statistically significant. (P = 0.095)

According to multinominal regression analysis, it was identified that age is significantly associated with severe periodontal disease (p < 0.001, OR = 1.043 per year increase) and Plaque score percentile is a strong predictor (p < 0.001, OR = 1.87), indicating a higher plaque score is linked to severe periodontal destruction.

Duration of SLT use shows a moderate positive correlation (0.322) with bleeding score percentile. This suggests that the prolonged betel chewing may contribute to increased gingival bleeding. Betel chewing itself has a weak positive correlation with bleeding score (0.135), plaque score (0.109), and severity of periodontal destruction (0.119). Ingredients used in betel chewing (such as slaked lime or catechu) show a slight negative correlation (–0.132) with severity of periodontal destruction. This suggests certain ingredients have a less harmful or protective effect.

3. Discussion

Periodontitis is a chronic inflammatory disease that affects 11 % of the global population,<sup>12</sup> significantly affecting impact on the quality of life of the individuals.<sup>11</sup> Concurrent research findings indicate that several modifiable and nonmodifiable risk factors such as socio-economic status, smoking, alcohol consumption, diabetes, obesity, hypertension, stress and genetic factors are associated with periodontitis.<sup>13</sup>

Smokeless tobacco is a mixture of areca, slaked lime and tobacco wrapped in a betel leaf, which is synonymous with betel quid or chewed betel. The habit of SLT consumption is common in some populations in South Asia.<sup>1</sup>

Previous studies have reported that the habit of SLT consumption is more common in women than in men,<sup>14</sup> because women spend more time at home than men do, and the habit is mostly passed down from

**Table 1**  
Percentage distribution of participants' oral health-related habits.

| Oral Health Habit |                                  | Gender N (%)  |                      |   |                      | Total (%) |
|-------------------|----------------------------------|---|----------------------|---|----------------------|-----------|
| A.                | Oral hygiene practices           | Female  |                      | Male  |                      |           |
|                   |                                  | Less than twice/day                                 | More than twice/day  | Less than twice/day                                 | More than twice/day  |           |
|                   |                                  |   |                      |   |                      |           |
|                   |                                  |   |                      |   |                      |           |
|                   |                                  |   |                      |   |                      |           |
| 1)                | Frequency of tooth brushing      | 28 (11.9)   | 207 (88.1)           | 31 (25.8)   | 89 (74.2)            | 355 (100) |
|                   |                                  | Fluoridated   | Non-fluoridated      | Fluoridated   | Non-fluoridated      |           |
| 2)                | Type of toothpaste               | 192 (81.7)  | 43 (18.3)            | 108 (90)  | 12 <sup>10</sup>     | 355 (100) |
|                   |                                  | Yes   | No                   | Yes   | No                   |           |
| 3)                | Use of interdental cleaning aids | 14 <sup>6</sup>                                     | 221 (94)             | 15 (12.5)   | 105 (87.5)           | 355 (100) |
|                   |                                  | After main meals only/<br><sup>a</sup> occasionally | *Several times a day | After main meals only/<br><sup>a</sup> occasionally | *Several times a day |           |
| B.                | Dietary habits                   |   |                      |   |                      |           |
|                   |                                  |   |                      |   |                      |           |
| 4)                | Consumption of cariogenic foods  | 203 (86.4)  | 32 (13.6)            | 98 (81.7)   | 22 (18.3)            | 355 (100) |
| C.                | Habit of smokeless tobacco use   |   |                      |   |                      |           |
|                   |                                  |   |                      |   |                      |           |
|                   |                                  | Ever  | Never                | Ever  | Never                |           |
| 5)                | Smokeless tobacco use            | 213 (90.6)  | 22 (9.4)             | 74 (61.7)   | 46 (38.3)            | 355 (100) |

Several times a day- Consumption of cariogenic foods not confined to after main meals, but where the participants use them more frequently as they wish.

<sup>a</sup> Occasionally denotes consumption of cariogenic foods only at several times a week or even less frequently (Ref NOHS).

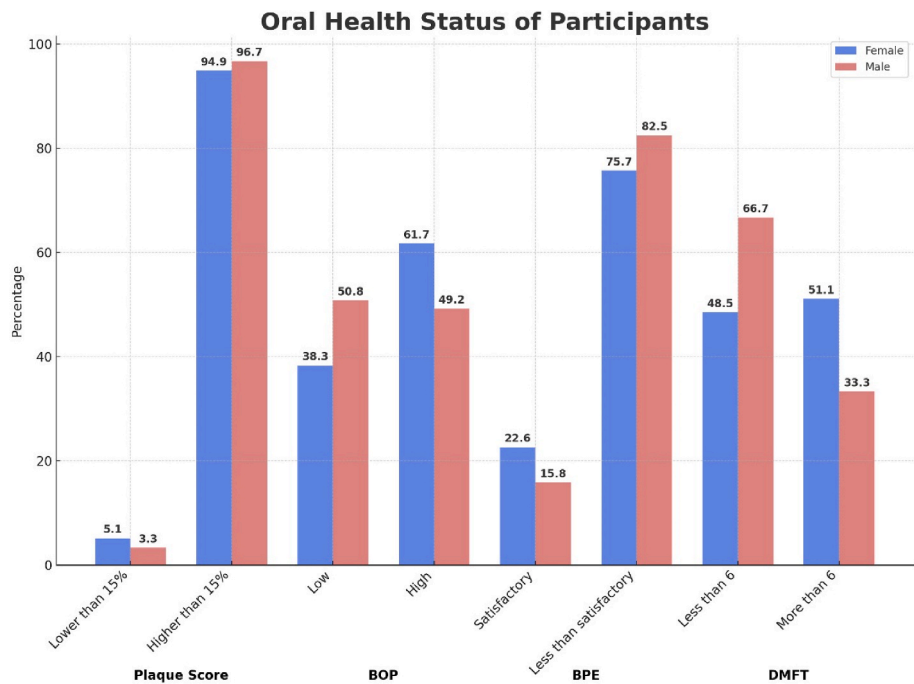


Fig. 1. Oral health Status of the Participants.

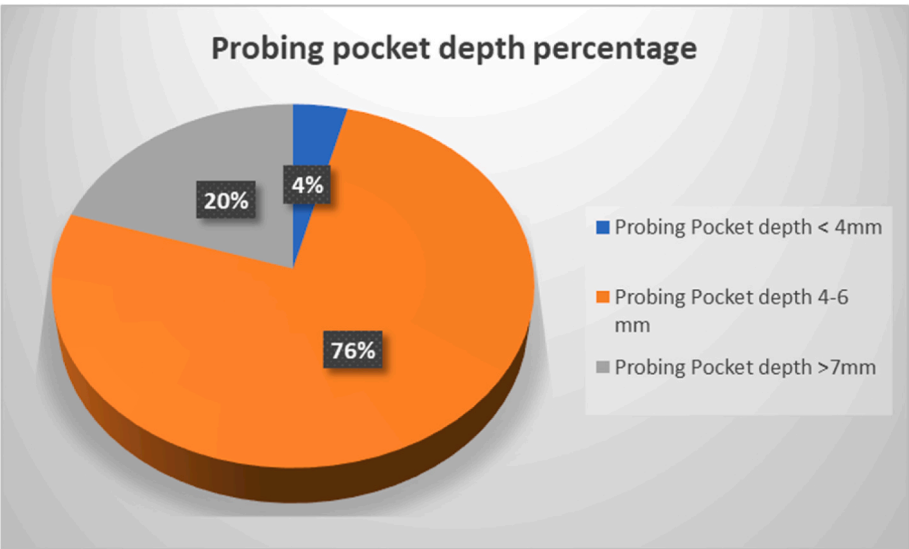


Fig. 2. Probing pocket depth percentages.

their parents<sup>15</sup> as well as from previous generations. Our study revealed similar findings approximately about 91 % of women consumed SLT, whereas 62 % of men who had the same habits. Most of the SLT consumers were residents from rural areas (72 %). In contrast, a study conducted in Myanmar<sup>18</sup> reported that the SLT habit was abundant in the urban population. Furthermore, Gupta et al. reported that men consumed SLT more than women did among the study participants.<sup>14</sup> While some of the findings are compatible and others are contradictory, similar trends in SLT habits have been reported in studies carried out in countries such as Sri Lanka and Taiwan.<sup>16,17</sup>

With respect to tooth brushing habits, the fact that a majority of study participants practiced brushing more than once a day (88 % and 74 % for females and males respectively) with a high percentage (85 %) using fluoridated toothpaste encouraged oral hygiene behavior. This finding is however different from those of previous studies where a

majority of participants (79 %) practiced brushing once a day, and only 41 % used toothpaste for brushing.<sup>19</sup> In contrast to the findings of the above study, Naser et al.<sup>20</sup> reported that approximately 71 % of the study participants brushed their teeth more than once a day. The vast majority of them (93.0 %) claimed to brush their teeth using toothpaste that contained 61.9 % fluoride.<sup>20</sup>

However, the use of interdental cleaning aids was minimal among the study participants. A statistically significant association was identified between the frequency of brushing and the use of interdental cleaning aids with Basic Periodontal Examination (BPE), and these results are compatible with the study done by Seker BK et al., 2022<sup>21</sup>

According to the literature, overall periodontal parameters denoting inflammatory conditions (plaque score, bleeding score, and periodontal pocket depths), the number of missing teeth and marginal bone loss are significantly greater in SLT users than nontobacco users.<sup>22,23</sup> The

**Table 2**  
Percent distribution of participants periodontal health status.

| Characteristic  | Periodontal Health              |                                     | Statistical significance of the association |  |
|---|---------------------------------|-------------------------------------|---|--|
| 1.) <b>Bleeding score</b>                               | < median value of 23.4<br>N (%) | ≥ median value of 23.4<br>N (%)     | Total N (%)                                 | X <sup>2</sup> = 7.329 df = 1<br>P = 0.007 |
| Ever users of SLT                                       | 132 (37.18)                     | 155 (43.66)                         | 287 (80.85)                                 | Total = 355 (100)                          |
| Never users of SLT                                      | 19 (5.35)                       | 49 (13.8)                           | 68 (19.15)                                  |  |
| 2.) <b>Basic Periodontal Examination (BPE) findings</b> | Indicated for OHI*              | Indicated for active PDD treatments | Total N (%)                                 | X <sup>2</sup> = 9.093 df = 1<br>P = 0.003 |
| Ever users of SLT                                       | 67 (19.2)                       | 214 (61.32)                         | 281 (80.52)                                 | Total = 349 (100)                          |
| Never users of SLT                                      | 5 (1.43)                        | 63 (18.05)                          | 68 (19.48)                                  |  |
| 3.) <b>Severity of PDD pocket depth</b>                 | <4 mm                           | 4–6 mm                              | >6 mm                                       | X <sup>2</sup> = 4.541 df = 2<br>P = 0.023 |
| Ever users of SLT                                       | 129 (36.34)                     | 103 (29.01)                         | 55 (15.49)                                  | Total = 355 (100)                          |
| Never users of SLT                                      | 19 (5.35)                       | 32 (9.01)                           | 17 (4.79)                                   |  |
| 4.) <b>Plaque score</b>                                 | Low                             | Moderate                            | High  | X <sup>2</sup> = 9.925 df = 2<br>P = 0.007 |
| Ever users of SLT                                       | 98 (27.61)                      | 102 (28.73)                         | 87 (24.51)                                  | Total = 355 (100)                          |
| Never users of SLT                                      | 19 (5.35)                       | 15 (4.23)                           | 34 (9.58)                                   |  |

OHI\* = Oral hygiene instructions.

findings of these studies are comparable with the findings of the present study, where the plaque and bleeding scores were significantly higher in SLT users than nonusers. In addition to the above findings, a statistically significant association was identified between consumption of SLT and the plaque score bleeding score and BPE.

The odds of SLT users having periodontal pockets greater than 4 mm were 3.64 times greater than those of nonusers.<sup>24</sup> According to a study performed by Arun Kumar et al., 2012,<sup>25</sup> there was a statistically significant increase in periodontal pocket depth among SLT users compared with nonusers. The findings of above study are in agreement with the findings of the present study.

Some limitations were identified when conducting this study. This study group was confined to adult patients from the Kandy district in Sri Lanka, and most of them were from rural areas. Therefore, the study sample may not be representative of the wider population in Sri Lanka. , Additionally, information was gathered from the participants in the form of a self-report questionnaire. Thus, the possibility of funder reporting of unhealthy habits such as tobacco and alcohol habits cannot be ruled out, and hence subjected to biases. Similarly, the presence of any undiagnosed medical conditions relevant under the exclusion criteria in the study sample could have contributed to further biases. Furthermore, clinical attachment loss (CAL) and marginal bone loss (MBL) were not assessed in this study and past periodontal status could not be ascertained. One of the major concerns was the obtaining patient consent for extensive clinical examination and this has been identified as a limitation of the study.

4. Conclusion

The results of this study revealed a statistically significant positive association between SLT consumption and periodontal health even though their brushing habits were satisfactory. Moreover, age is significantly associated with severe periodontal disease while Plaque score percentile is a strong predictor, indicating a higher plaque score is linked to severe periodontal destruction.

Therefore, patients should be made aware of the adverse effects of SLT which are related not only to premalignant and malignant conditions but also to periodontal destruction leading to premature loss of teeth. Public health efforts should focus on educating individuals, promoting cessation, and reducing the use of smokeless tobacco to prevent the devastating effects it has on oral and general health.

Patient consent

Written informed consent was obtained from all participants.

Ethical clearance

This research proposal was approved by the Ethical Review Committee (ERC/FDS/UOP/2020/35)

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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