

# Comparison of Oral Hygiene Status of Adult Individuals using Charcoal Toothbrushes and Regular Nylon Toothbrushes in a Nigerian Health Facility.

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ABSTRACT

**Background:** Poor periodontal health is a global concern that affects the quality of life. The high prevalence of periodontal disease in adolescents, adults, and older individuals makes it a public health concern. Although studies have been reported on the efficacy of charcoal-infused versus Nylon toothbrushes on plaque control, there appears there is a lack of consensus among documented reports. The objective of the study was to compare the oral hygiene status of individuals using a charcoal-infused toothbrush and a regular nylon bristle toothbrush.

**Methods:** This was a randomized clinical crossover study. This study recruited all consecutive participants who presented to the Department of Periodontics at the University of Benin Teaching Hospital, Benin City, for scaling and polishing, between the period of May 2022 to April 2023. Those with severe periodontal diseases and those who did not consent to participate were excluded from the study. Each participant made use of each toothbrush; Charcoal-infused (test group) versus Nylon toothbrush (control group). Participants were instructed to brush with either toothbrush and the same fluoride toothpaste, morning and evening after meals, for three minutes and with the modified Bass technique. They were recalled after three weeks for assessment and the PI, OHI-S, GI, and CPITN were recorded at baseline and after three weeks of the use of the toothbrushes. After six months of washout, the toothbrush was exchanged, and the same procedure and assessments were done. Data collected were Biodata (age, sex, marital status, occupation, education, and ethnic group) and records of PI, OHI-S, GI, and CPITN values. Both descriptive and inferential statistics were performed. A level of significance was set at  $p < 0.05$ . All analysis was done with SPSS software version 26 (IBM, Armonk, New York, US).

**Results:** A total of twenty - two adults with a mean age of  $32.82 \pm 12.19$  years were recruited in this study. There was a statistically significant difference in the age distribution between the two toothbrush sequence categories ( $p = 0.006$ ). In the first period, the mean PI at baseline in participants who used Nylon Bristles was  $(1.36 \pm 0.51)$  reduced 3 weeks later to  $1.00 \pm 0.01$  ( $p = 0.038$ ). Participants who used Charcoal-infused toothbrushes had their baseline mean PI  $(1.91 \pm 1.22)$  reduced to  $0.82 \pm 0.41$  ( $p = 0.01$ ). During the second period, the baseline mean PI was  $1.09 \pm 0.30$  reduced to  $0.45 \pm 0.52$  ( $p = 0.006$ ) after the Nylon bristle toothbrush. While for the Charcoal-infused toothbrush, the mean baseline PI was  $(0.82 \pm 0.60)$  reduced to  $0.27 \pm 0.47$  over three weeks ( $p = 0.002$ ). The regular Nylon bristle toothbrush did not give a better OHI-S than the charcoal-infused toothbrush ( $p = 0.806$ ). Both toothbrushes impacted the plaque levels and oral hygiene status. However, there was no statistically significant difference in PI and OHI-S. ( $p = 0.757$ ,  $p = 0.806$ , respectively) in comparison to either toothbrush after the three weeks of use.

**Conclusion:** A charcoal-infused toothbrush was not better than the Nylon bristle toothbrush in reducing plaque levels. and improving the oral hygiene status of participants in this study over three weeks. Although, plaque levels were minimized with the use of both the charcoal-infused bristles and nylon bristle toothbrushes. Oral hygiene status was also improved by the use of both interventional tools.

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## INTRODUCTION

Periodontal health is related to oral health and ultimately general well-being (Fischer *et al.*, 2020). Periodontitis is the most common chronic inflammatory disease seen in humans, with considerable impacts on individuals and society (Greaves, 2012). People with untreated periodontitis which is an oral disease, result in preventable pain, infection, and reduced quality of life, as well as missed school and productivity losses. Poor oral health may be associated with medical conditions such as heart disease, stroke, diabetes, pneumonia, and other respiratory diseases. Good oral health is also necessary for healthy aging, playing a crucial role concerning nutrition, employment, self-esteem, and continued social interaction. It is therefore necessary to preserve periodontal and oral health status. Supragingival plaque removal is considered to be of utmost importance in the decline of the prevalence of caries, gingivitis, and periodontitis (Chapple *et al.*, 2015).

Periodontal health and oral health status can be maintained with proper plaque removal measures since the primary aetiologic factor of periodontal diseases is bacterial plaque (Genco, 1996; Petersen *et al.*, 2005). Plaque removal measures include the use of manual toothbrushes and dentifrices, tooth floss, interdental brushes, and mouth rinses. The efficacy of mechanical plaque control with a manual toothbrush depends on user dexterity, technique, force, duration, and frequency during brushing (Genco, 1996).

The choice of an individual's toothbrush design is determined by his oral health needs. The toothbrush design is dependent upon toothbrush head size, shank angulation, bristle material, and arrangement. The brushing plane of toothbrushes is determined by the bristle length and angulation (Genco, 1996). The nylon bristle toothbrush is commonly used with varying bristle diameter, length, taper, and arrangement within tuft slots in the head of the toothbrush (Genco, 1996).

The bending, splaying, and flaring of worn bristles possibly affect their plaque removal efficacy requiring the replacement of toothbrushes (Bergenholtz *et al.*, 1984). The accessibility of the toothbrush's bristles to remove plaque from the tooth surfaces along the gingival margin depends on the bristle diameter and on whether bristle tips are rounded or tapered (Genco, 1996).

The blending of charcoal into nylon bristles can reduce halitosis, reduce plaque, and also kill bacteria (Terézhalmy *et al.*, 2008). Bristles of charcoal toothbrushes are black and are prepared by blending *binchotan* charcoal into nylon

bristles (Hussain, 2019). When Charcoal is exposed to high temperatures often in combination with gases such as oxygen during manufacturing, it becomes activated. Charcoal when activated has a high absorptive capacity (Terézhalmy *et al.*, 2008).

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When a form of carbon is treated it essentially becomes activated charcoal. The treatment involves the removal of water and other volatile constituents from carbon-based materials, such as bamboo, wood, or coconut husk and shell, to make the surface of its particles porous (Hussain, 2019). The pores act like magnets for other particles like dirt and oil which it absorbs, allowing all of the unwelcome substances to be swept away when the charcoal is washed off (Hussain, 2019).

In theory, charcoal binds to everything in its path like stains, tartar, bacteria, viruses, and even the tonsils (Terézhalmy *et al.*, 2008). Extrinsic stains slowly accumulate on the outermost part of the tooth structure, the enamel. These gradually developing stains are due to certain substances in caffeine, wine, smoking, and some stain-producing foods (Hussain, 2019). Extrinsic stains are the secondary causative factor for periodontal disease (Hussain, 2019). The more the stain, the more plaque, the more the disease, and the poorer the oral hygiene status.

Activated charcoal helps to push up the pH level of the oral cavity primarily because it can bind with acidic components in plaque and results in their accelerated removal from the oral cavity. Nylon bristles toothbrush is the most commercially available toothbrush manufactured (Yang *et al.*, 2010). Nylon bristles were copies of natural bristles in length and thickness initially (Yang *et al.*, 2010). They were stiffer than natural bristles of similar diameters and did not have the hollow stem of natural bristles, and thus did not absorb water (Yang *et al.*, 2010). However, compared to natural bristles, nylon filaments have additional advantages; they can be in various uniform diameters and shapes; and end-rounded to be gentle on gingival tissues during brushing (Yang *et al.*, 2010). However, the charcoal blended into nylon bristles toothbrush gives an added advantage of binding to the acidic components of plaque and improving plaque removal. Therefore, it will be necessary to compare the effectiveness of charcoal and nylon toothbrushes in maintaining periodontal and oral health status. Thus, activated

charcoal helps to remove plaque and results in relieving halitosis(Terézhalmy *et al.*, 2008).

Tooth brushing is the most widely used method for plaque control, and a wide variety of toothbrushes are commercially available. Studies comparing the efficacy of available toothbrushes are scarce(Rosing CK, Cavagni J, 2016). In a study among dental practitioners, there was also low awareness and knowledge of charcoal-based products(Hussain, 2019). The use of a charcoal toothbrush was recommended in a study, as it demonstrated better plaque removal efficacy as compared to plain nylon bristle(Pertiwi, Eriwati and Irawan, 2017). Thus it is necessary to have an efficient plaque removal measure for maintaining both periodontal and oral health status, especially in our setting.

Traditionally our forefathers used charcoal which aided in good dental plaque control; however, studies have not been done to test their effectiveness, efficacy, and efficiency in our setting. A major point raised by a previous study was that charcoal-infused bristle toothbrushes had better plaque control efficacy than regular nylon toothbrushes among dental students. <sup>11</sup> Thus in areas such as ours, it will be necessary to know the plaque control effectiveness by comparing the Charcoal-infused bristles toothbrush versus the regular Nylon toothbrush; to provide alternative oral hygiene methods to persons who may be aware of charcoal used for oral hygiene practice however unsure of its effect and safety. Also, a paucity of studies has been reported in Nigeria to demonstrate the efficacy of charcoal-infused toothbrushes compared to nylon bristle toothbrushes in maintaining oral hygiene status. The aim therefore is to compare the oral hygiene status of persons using charcoal-infused toothbrushes with those using regular nylon bristles.

## MATERIALS AND METHODS

Following ethical approval (ADM/E/A/VOL, VII/14831070), a randomized clinical crossover study was conducted between May 2021 to May 2022 among adult participants who presented to the Periodontics clinic, of a Nigerian Tertiary health facility. These adults used both the regular nylon toothbrushes and the new charcoal-infused bristle toothbrushes or vis-a-vis. Individuals who met the inclusion criteria, presented for dental treatment, and gave their consent, were recruited into the study.

Inclusion criteria included Adults 18 years and above and without co-morbidities. (Hypertension, Diabetes). Subjects without habits and conditions

that cause reduced saliva. Subjects not wearing orthodontic or prosthetic appliances. Subjects without crowding. Subjects who were not antimicrobials or analgesics. Subjects who did not report tobacco use in any form. Subjects without mouth breathing and occlusal parafunction.

This clinical study was registered with the Pan African Clinical Trial Registry ([www.pactr.org](http://www.pactr.org)) database, with an identification number; PACTR202305892616028.

A sample size of 22 was calculated with the Siyasinghe and Sooriyarachichi formula(Siyasinghe & Sooriyarachichi, 2011).

$$(n = \frac{(Z_{\alpha/2} + Z_{\beta})^2 \sigma_m^2}{2(\mu_1 - \mu_2)^2})$$

The data collected were age, gender, occupation, level of education, and marital status. Other data collected were recorded on the proforma provided; on the assessment of Plaque, Oral Hygiene status, gingival status, and Community Periodontal Index for Treatment Needs. Oral Examination was done with a Dental mirror and an Explorer

A Pre-test was also conducted. This involved 4 participants (18% of the sample size) that were not part of the study; before the commencement of the study. Two of the participants used charcoal toothbrushes and the other two used regular nylon toothbrushes to assess their adherence to the oral hygiene instructions with the same frequency, timing, and technique following the use of the toothbrush.

Participants were selected using a systematic sampling technique, by choosing the second person with a sampling interval (Population/sample size=30/15) of two, after random sampling of the first sample fulfilling the selection criteria as they present. A clinical examination was performed on the dental chair. Assessments were done for the Plaque, Oral hygiene, and Periodontal status with the use of the Turesky-modified Quigley Hein plaque index, Simplified Oral hygiene index, gingival index, and the community periodontal index of treatment needs (CPITN) Index. Oral hygiene instructions; were given on the frequency, sequence, and timing of tooth brushing. The standard brushing instructions involve the use of either a Charcoal-infused or regular Nylon toothbrush with a Modified Bass brushing technique for three minutes twice a day after meals (morning and evening), and brushing each quadrant six times. They also used fluoride-containing toothpaste provided for them. Participants were also discouraged from using other mechanical or chemical plaque control methods. They had oral prophylaxis. Two participants were assessed in a day, thrice a week.

A ballot form of random sampling: using sealed envelopes was given to participants to determine what toothbrush to use first.

#### Introductory and First Appointment

Initial oral prophylaxis was done to take the plaque score to zero. There was a recall of one day without brushing to allow the build of plaque for the baseline, and a record of the assessments for PI, OHI-S, CPITN, and GI. Eleven participants had one charcoal-infused bristle toothbrush each, while the other eleven were given one nylon bristle toothbrush each, for use in three weeks.

#### Second Appointment

Participants' plaque index, Simplified Oral hygiene index, Gingival index, and the community periodontal index of treatment needs (CPITN) Index, were assessed and the records were documented. The first toothbrush was retrieved, and the oral hygiene instruction re-emphasized. Participants were encouraged to use their previous plaque control method and return after six months.

#### Crossover and Third Appointment

There was a washout period of six months, and participants came for a third appointment.

A second oral prophylaxis to standardize the patient (take the plaque score to zero) was carried out. There was a recall of one day without brushing to allow the build of plaque for the baseline of the second phase of intervention and a record of the assessments of PI, OHI-S, CPITN, and GI was taken. The toothbrushes (Charcoal-infused, regular Nylon) were given for another three weeks, such that those who used charcoal in the first phase got the nylon toothbrush. Oral hygiene instructions were re-emphasized.

#### Fourth Appointment

The assessment was done using the Plaque index, GI, OHI-S, and CPITN after three weeks, and measurements were recorded.

Study participants were assessed for baseline parameters, plaque levels, oral hygiene, and periodontal status before and after three weeks of using the different experimental toothbrushes.

Both descriptive and inferential statistics were performed. In descriptive statistics, the categorical data were presented as frequency and percentages while the continuous data were summarised as range, means, and standard deviation. In inferential statistics, of group differences in variables, such as an independent t-test, paired t-test, and ANOVA (Analysis of Variance test) are employed. The level of significance was set at  $p < 0.05$ . All data was analyzed using SPSS version 26 (IBM, Armonk, New York, US).

#### RESULTS

A total of 22 participants were recruited for this crossover study. There were more females (13, 59.1%) than males (9, 40.9%) in the study. The mean age of the study participants was  $32.82 \pm 12.19$  years. There was a statistically significant difference in the age distribution between the two toothbrush sequence categories ( $p = 0.006$ ). There was also a statistically significant difference in marital status ( $p = 0.010$ ) and occupational level ( $p = 0.009$ ). However, these important differences will not affect the study outcomes as this was a crossover study, where all participants received both interventions and served as their controls.

Table 1: Socio-demographic Characteristics of the Study Participants

| Variable             | Sequence (N=22)           |   | Total       | Statistic      | P value |
|----------------------|---------------------------|---|-------------|----------------|---------|
|                      | †N <sub>1</sub><br>(n=11) | C <sub>2</sub> C <sub>1</sub> - N <sub>2</sub> (n=11) |             |                |         |
| Sex                  |                           |   |             |                |         |
| Male                 | 6(54.5%)                  | 3(27.3%)  | 9(40.9%)    | Yates=0.752    | 0.386   |
| Female               | 5(45.5%)                  | 8(72.7%)  | 13(59.1%)   |                |         |
| Total                | 11(100%)                  | 11(100%)  | 22(100%)    |                |         |
| Age Category (years) |                           |   |             |                |         |
| ≤20                  | 0(0%)                     | 4(36.4%)  | 4(18.2%)    | Fishers=11.242 | 0.006*  |
| 21-30                | 1(9.1%)                   | 5(45.5%)  | 6(27.3%)    |                |         |
| 31-40                | 6(54.5%)                  | 1(9.1%)   | 7(31.8%)    |                |         |
| ≥41                  | 4(36.4%)                  | 1(9.1%)   | 5(22.7%)    |                |         |
| Total                | 11(100%)                  | 11(100%)  | 22(100%)    |                |         |
| Mean Age             | 40.82±9.32                | 24.82±9.17  | 32.82±12.19 | T=4.057        | 0.001*  |
| Marital status       |                           |   |             |                |         |
| Single               | 2(18.2%)                  | 8(72.7%)  | 10(45.5%)   | Yates=6.600    | 0.010*  |
| Married              | 9(81.8%)                  | 3(27.3%)  | 12(54.5%)   |                |         |
| Total                | 11(100%)                  | 11(100%)  | 22(100%)    |                |         |

| Educational Level                |          |          |           |                |       |
|----------------------------------|----------|----------|-----------|----------------|-------|
| Primary                          | 1(9.1%)  | 0(0%)    | 1(4.5%)   | Fishers=2.062  | 0.476 |
| Secondary                        | 1(9.1%)  | 0(0%)    | 1(4.5%)   |                |       |
| Tertiary                         | 9(81.8%) | 11(100%) | 20(90.9%) |                |       |
| Total                            | 11(100%) | 11(100%) | 22(100%)  |                |       |
| Ethnic group                     |          |          |           |                |       |
| Edo                              | 5(45.5%) | 7(63.6%) | 12(54.5%) | Fishers=4.529  | 0.200 |
| Esan                             | 2(18.2%) | 4(36.4%) | 6(27.3%)  |                |       |
| Igbo                             | 1(9.1%)  | 0(0%)    | 1(4.5%)   |                |       |
| Others                           | 3(27.3%) | 0(0%)    | 3(13.6%)  |                |       |
| Total                            | 11(100%) | 11(100%) | 22(100%)  |                |       |
| ISCO Occupational Classification |          |          |           |                |       |
| Level I                          | 0(0%)    | 6(54.5%) | 6(27.3%)  | Fishers=10.233 | 0.009 |
| Level II                         | 5(45.5%) | 1(9.1%)  | 6(27.3%)  |                |       |
| Level III                        | 4(36.4%) | 4(36.4%) | 8(36.4%)  |                |       |
| Level IV                         | 2(18.2%) | 0(0%)    | 2(9.1%)   |                |       |
| Total                            | 11(100%) | 11(100%) | 22(100%)  |                |       |

† N<sub>1</sub> - C<sub>2</sub>= Nylon bristle (1st period) Charcoal-infused (2nd period) Group; C<sub>1</sub> - N<sub>2</sub>= Charcoal-infused (1st period) then Nylon bristle (2nd period) Group. ISCO: International Standard Classification of Occupations (OPEODU et al., 2009)

In the first period, the mean PI at baseline in participants who used Nylon Bristles was (1.36±0.51) reduced 3 weeks later to 1.00±0.01 (p=0.038). Participants who used Charcoal-infused toothbrushes had their baseline mean PI (1.91±1.22) reduced to 0.82±0.41 (p =0.01). During the second period, the baseline mean PI was 1.09±0.30 reduced to 0.45±0.52 (p=0.006) after the Nylon bristle toothbrush. As shown in Table 5 below, there were no significant carryover effects [F (1,39) = 0.078, p=0.781]; and Period effect [F (1,39) = 0.546, p=0.465] on the treatment effect on OHI-S evaluated 3 weeks post interventions.

Table 2: Mean values of PI in participants using Charcoal-infused toothbrushes and those using regular Nylon bristle toothbrushes.

| Group                           | Time point     | Nylon     | Charcoal  | T statistic | P-value |
|---------------------------------|----------------|-----------|-----------|-------------|---------|
| N <sub>1</sub> - C <sub>2</sub> | 24 hours       | 1.36±0.51 | 1.91±1.22 | T= -1.369   | 0.186   |
|                                 | 3 weeks        | 1.00±0.01 | 0.82±0.41 | T=1.491     | 0.152   |
|                                 | <i>P value</i> | 0.038*    | 0.010*    |             |         |
| C <sub>1</sub> - N <sub>2</sub> | 24 hours       | 0.82±0.60 | 1.09±0.30 | T=-1.342    | 0.195   |
|                                 | 3 weeks        | 0.27±0.47 | 0.45±0.52 | T=-0.861    | 0.400   |
|                                 | <i>P value</i> | 0.002*    | 0.006*    |             |         |
| Overall                         | 24 hours       | 1.09±0.61 | 1.50±0.96 | T=-1.682    | 0.101   |
|                                 | 3 weeks        | 0.68±0.48 | 0.63±0.49 | T=0.311     | 0.757   |
|                                 | <i>P value</i> | 0.004*    | <0.0001*  |             |         |

† N<sub>1</sub> - C<sub>2</sub>= Nylon bristle (1st period) Charcoal-infused (2nd period) Group; C<sub>1</sub> - N<sub>2</sub>= Charcoal-infused (1st period) then Nylon bristle (2nd period) Group

As shown in Table 3 below, within the participants that used a Nylon toothbrush in the first period and then a Charcoal toothbrush in the second period after the washout, there was no statistical significance in the OHI-S scores after Nylon use ( $1.53 \pm 0.62$ ) and Charcoal toothbrush use ( $1.51 \pm 0.88$ ) after a 3-week assessment period, with  $p = 0.949$ . In the participants that used Charcoal-infused toothbrushes in the first period, and then Nylon in the second phase of the study, assessment of the post-intervention OHI-S scores after three weeks for charcoal use ( $0.08 \pm 0.19$ ) and Nylon use ( $0.20 \pm 0.60$ ) was not statistically different at  $p = 0.541$ . There was a pattern of statistically significant reduced mean OHI-S values over 3 weeks with the use of a Nylon toothbrush in the first period ( $p = 0.004$ ), and in the second period

( $p < 0.0001$ ). There was also a statistically significant reduction in the mean OHI-S values with the Charcoal-infused toothbrush in the first period ( $p < 0.0001$ ). There was also a statistically significant reduction in the mean OHI-S values with the Charcoal-infused toothbrush in the first period ( $p < 0.0001$ ; also, there was a significant reduction in OHI-S values across the 3 weeks with Charcoal toothbrush use from  $1.99 \pm 0.89$  to  $0.8 \pm 0.96$  with  $p < 0.0001$ . Overall, mean baseline values of OHI-S before toothbrush intervention irrespective of the treatment period were not statistically different for the study participants ( $p = 0.821$ ). There was no statistically significant difference in mean OHI-S values after 3 weeks of each treatment ( $p = 0.806$ ).

34 Table 4: Mean values of OHI-S among participants using Charcoal-infused toothbrushes

Table 3: Mean values of OHI-S among participants using Charcoal-infused toothbrushes and those using regular Nylon bristle toothbrushes.

| Group                           | Time point     | Nylon     | Charcoal  | T statistic | P-value |
|---------------------------------|----------------|-----------|-----------|-------------|---------|
| N <sub>1</sub> - C <sub>2</sub> | 24 hours       | 2.60±0.59 | 2.32±0.99 | T=0.783     | 0.443   |
|                                 | 3 weeks        | 1.53±0.62 | 1.51±0.88 | T=0.065     | 0.949   |
|                                 | <i>P value</i> | 0.004*    | 0.005*    |             |         |
| C <sub>1</sub> - N <sub>2</sub> | 24 hours       | 1.51±0.64 | 1.66±0.67 | T=-0.554    | 0.586   |
|                                 | 3 weeks        | 0.20±0.60 | 0.08±0.19 | T=0.622     | 0.541   |
|                                 | <i>P value</i> | <0.0001*  | <0.0001*  |             |         |
| Overall                         | 24 hours       | 2.05±0.82 | 1.99±0.89 | T=0.228     | 0.821   |
|                                 | 3 weeks        | 0.87±0.91 | 0.80±0.96 | T=0.247     | 0.806   |
|                                 | <i>P value</i> | <0.0001*  | <0.0001*  |             |         |

Table 4: Diagnostic tests: Analysis of variance table to test for Sequence and Period effects on OHI-S

| Source          | Df | Type III SS | F value | P value |
|-----------------|----|-------------|---------|---------|
| Sequence effect | 1  | 0.025       | 0.078   | 0.781   |
| Period          | 1  | 0.175       | 0.546   | 0.465   |
| Error           | 39 | 12.534      | -       | -       |

Key: Sequence effect: This refers to the effect when participants are allocated to a particular sequence (C-N OR N-C) which may affect the results. <sup>a</sup>NB: the study was designed such that any possible carryover effect was eliminated using a sufficient washout period of 6 months. Period effect = The period effect refers to the possible differential effect of the same treatment received at two different periods (LIM CY & IN J, 2009)

## DISCUSSION

Periodontal diseases are prevalent in developed and developing countries and affect about 20-50% of the global population (Janakiram et al., 2022).

This high prevalence of periodontal diseases, in adolescents, adults, and older individuals makes it a public health concern (Bhimani & Kothiwale, 2017). Several studies on the Prevalence of

periodontal diseases in Nigeria have been on the increase with a varied rate from 15% to about 90%(Nazir et al, 2017), (Jafer et al., 2016; Popoola & Dosumu, 2015; Kolawole & Oziegbe, 2011; Soroye, 2014; Ohamaeme et al., 2017). Periodontal diseases have been known to have a considerable impact on our society,(Greaves, 2012) and if left untreated cause reduced quality of life, missed school attendance, and productivity losses. It is, therefore, necessary to preserve periodontal and oral health status using proper plaque removal measures (Genco, 1996) like nylon bristle or charcoal-infused toothbrushes. It has also been established that the primary aetiologic factor of periodontal disease is bacterial plaque(Petersen et al., 2005Genco, 1996). Consequently, this study is aimed to compare the effectiveness of charcoal and nylon toothbrushes in maintaining oral health status and periodontal status.

A total of twenty-two participants participated in this study with 100% participation.

This study was conducted as a cross-over study so that the participants acted as their controls; their technique, duration, sequence, and frequency in brushing remained similar during both phases with the use of the toothbrushes(Terézhalmy et al., 2008). The participants were blinded to the interventional toothbrushes (Charcoal-infused and regular Nylon) given to them using sealed envelopes at the different phases of the study to remove the Hawthorne effect (knowledge of an intervention influencing the outcome) experienced in a study with a single toothbrush use (Ohamaeme et al., 2017).

This study was carried out with each toothbrush, used over three weeks during each phase of the study (Soroye, 2014), with assessments for PI, OHI-S, CPITN, and GI performed at baseline and three weeks from baseline for both phases of the intervention. The toothbrush was used for three weeks to utilize the utmost efficacy of the toothbrush as some toothbrushes experience wear by one month from commencement of use.

Oral hygiene instructions; were given to all participants to adhere to a similar technique (modified Bass), sequence (six times on each quadrant), duration (3 minutes), and frequency morning and evening every day) to subject both toothbrushes to similar patterns of use(Kini et al., 2019). A pre-test comprising four volunteer participants, was carried out to assess their adherence to the oral hygiene instructions with the same frequency, timing, and technique; in the use of the toothbrush. The outcome was satisfactory, and further educated them; on their oral health promotion. Participants were monitored with

phone calls to remind them of the instructions and their dates of appointments.

All participants were given oral prophylaxis at the baseline and after the washout period of six months to standardize them. Then participants were given a day recall to allow for the build of plaque without brushing at night, and assessments for the baseline were done. At the end of the three weeks for each phase of the study, assessments of the PI, OHI-S, CPITN, and GI were also done.

The modified Bass technique was chosen for this study as the bristle tips removed plaque from the cervical area of teeth along the free gingival margin and facilitated intra-sulcular brushing without causing abrasive trauma to the gingiva(Fischer et al., 2020).

More females (59.1%) were found to be present in this study, and this was also similar (72%) in the study by Kini et al, who studied the plaque removal efficacy and bristle wear between charcoal-infused and nylon bristle toothbrushes(Kini et al., 2019). This predominance of females could be attributed to the better oral health-seeking behaviour that is among them (Thamke et al., 2018;Omitola OG, 2010). Although there was no significant difference among the gender in the toothbrush categories in this study, there was a significant difference among gender in PI, OHI-S, and brushing frequency in a study by Kolawole et al, in western Nigeria(Kolawole & Oziegbe, 2011) and another study in India(Kaur., 2021). The male gender had better OHI-S scores, attributed to a better knowledge of their oral hygiene practice. However, this is in contrast to a study (Kaur, 2021) also in western Nigeria, where oral hygiene was better among females, attributed to the females being more self-conscious with their appearance than males. Occupation influenced the oral hygiene of participants in this study, as there was a statistically significant difference (0.009) in their oral hygiene status. Similarly, to the study by Bamigboye et al; the reason might be due to a good knowledge of brushing with plaque removal tools shown by both study participants (Bamigboye & Akande, 2007). However, in a study by Santhosh et al., the oral hygiene scores (0.046) of the students were dependent on the occupation of their fathers which impacted their knowledge of oral hygiene practice(Santhosh et al., 2013).

In the first period of this study, participants who used Nylon toothbrushes had their mean PI values significantly reduced ( $p=0.038$ ). This reduction in plaque levels with the nylon toothbrush in the first period from  $1.36\pm 0.51$  was significant in three weeks to  $1.00\pm 0.01$  ( $p=0.038$ ), showing that the nylon brush is still a good plaque removal tool as

compared to the charcoal toothbrush that caused a reduction in plaque levels in the second period, from  $1.09 \pm 0.30$  and reduced to  $0.45 \pm 0.52$  ( $p = 0.006$ ). This reduction in plaque levels was also found in similar studies (Ohamaeme et al., 2017; Versteeg et al., 2008; Omitola, 2010). This finding can be added to the established mechanism of the mechanical cleansing action of nylon toothbrushes coupled with the combined natural chemical with the mechanical action of the charcoal toothbrush.

However, this conclusion is at variance with the study by Kini et al, where the intergroup difference in PI was higher for T<sub>1</sub> (charcoal toothbrush) as compared to T<sub>2</sub> (nylon toothbrush) ( $p = 5.30 \times 10^{-8}$ ), an indication that the plaque removal was better at baseline for T<sub>2</sub> (nylon toothbrush) as compared to T<sub>1</sub> (charcoal toothbrush) (Kini et al., 2019). In another study in India comparing manual, powered, and charcoal toothbrushes, a mean reduction in plaque scores was statistically significant for all three brushes, i.e., Manual, Powered, and Charcoal from baseline to 3 weeks ( $P = 0.017, 0.019, 0.018$ ), respectively however intergroup comparison with P values, ( $P = 0.776, 0.122, 0.052$ ) was found to be statistically non-significant (Prusty & Sharma, 2021). This plaque reduction was attributed to the mechanism of action of the brushes; crisscross action with mechanical cleansing effect for the manual brush; mechanical action along with the natural cleansing effect of charcoal for the charcoal brush; and for the powered toothbrush; oscillating and rotating motion which works through mechanical contact between bristles and tooth to remove plaque bio-film in addition to the biophysical action of cavitations (Thamke et al., 2018). However, there was no significant difference in the overall treatment effects on the PI between participants who used regular nylon bristle toothbrushes and charcoal-infused toothbrushes in this study ( $p = 0.757$ ). This finding suggested that the plaque control using both toothbrushes was good enough to improve and maintain their oral hygiene status. Oral hygiene status was significantly improved by the use of both interventional tools. Although there was an improvement in the OHI-S in the use of both the charcoal and the nylon toothbrushes independently (Nylon mean values  $2.62 \pm 0.59$  reduced to  $1.53 \pm 0.62$ ; Charcoal mean values  $2.32 \pm 0.99$  reduced to  $1.51 \pm 0.88$ ), there was no significant difference in the overall treatment effects on the OHI-S between participants who used regular Nylon bristle toothbrushes and charcoal-infused toothbrushes ( $p = 0.806$ ). This finding could be due to the short period of use of

the plaque removal tools. This finding of insignificant difference between the two comparable brushes was also in similar studies by Thamke et al, Prusty et al, Janakiram et al, and Somnath et al. However, in a study comparing a charcoal toothbrush to a Colgate sensitive toothbrush in plaque removal by Kaur et al (2021). There was a significant difference in the use of charcoal toothbrush when compared to a sensitive nylon toothbrush after six weeks of use as the charcoal brush was better in maintaining the oral hygiene than the Colgate sensitive toothbrush. Similarly, Kini et al, concluded in their study that the charcoal-infused bristle toothbrush had a better plaque control efficacy than the regular nylon bristle toothbrush (Kini et al., 2019). This might be due to the long period of 3 months and six weeks that their studies covered.

#### CONCLUSION.

The charcoal-infused toothbrush was not better than the Nylon bristle toothbrush in reducing plaque levels. The charcoal-infused toothbrush was not better than the Nylon bristle toothbrush in improving oral hygiene status. Although, plaque levels were minimized with the use of both the charcoal-infused bristles and nylon bristle toothbrushes. Oral hygiene status was also improved by the use of both interventional tools

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#### CONFLICT OF INTEREST

The authors declare no conflict of interest related to the study

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