

# Assessment of Knowledge and Practice of Toothbrush Contamination and Disinfection among Dental Students in Chengalpet District, Tamil, Nadu, India: A Cross-sectional Study

AB ANU<sup>1</sup>, KARTHIKEYAN INDRAPRIYADHARSHINI<sup>2</sup>, SUBRAMAN VISHNU PRASAD<sup>3</sup>,  
RAVI KARTHIKAYAN<sup>4</sup>, JAGADESON MAHESH<sup>5</sup>, MP REVANTH<sup>6</sup>



## ABSTRACT

**Introduction:** Toothbrushes and dental floss are imperative for removing dental biofilm and preventing dental caries and periodontal diseases. Toothbrushes become contaminated after repeated usage. Contaminated toothbrushes may be a significant contributor to systemic and oral diseases. It is the responsibility of dentists to inform their patients about preventive oral health behaviours, to promote improved oral hygiene in society.

**Aim:** To evaluate dental students' knowledge and practice about toothbrush contamination and disinfection in Chengalpet district, Tamil Nadu, India.

**Materials and Methods:** The present cross-sectional study was conducted among 232 dental students from January 2023 to June 2023 at a private dental college, Chengalpet, Tamil Nadu, India. A structured questionnaire consisting of two domains, with 16 questions was prepared, validated, and distributed to the third years, final years, and interns to assess the knowledge (8 questions) and practice (8 questions) about toothbrush contamination and disinfection. The descriptive analysis of

demographic variables was done and knowledge score and attitude score were performed using the Kruskal-Wallis H test. The p-value<0.05 was considered statistically significant.

**Results:** The participants of the present cross sectional study had a mean age of 23.49±1.56 years, with 36 (15.5%) males and 196 (84.4%) being female. The study values revealed that there was no statistically significant difference regarding the knowledge about toothbrush contamination between interns, final years and third years (p=0.806) and the further values obtained from the study revealed there was no statistically significant difference regarding the practice followed for toothbrush disinfection between all three groups (p=0.613).

**Conclusion:** According to the study results there was no statistically significant difference in the knowledge and practice of toothbrush contamination and disinfection among the interns, final years, and third years. Since their education and expertise may allow them to enforce it on their patients, dental students ought to be required to learn more about this, thereby encouraging better oral hygiene.

**Keywords:** Biofilm, Dental caries, Dental floss, Periodontal diseases

## INTRODUCTION

The use of toothbrushes and dental floss is imperative for removing dental biofilm and for preventing dental caries and periodontal diseases. Although toothbrushes are an effective mode of controlling plaque mechanically, they can harbour bacteria in healthy, diseased, or medically ill patients [1].

Toothbrushes are sterile after their manufacturing [2] and they get contaminated immediately after the first brushing [3]. The contamination of toothbrushes occurs early after initial use and increases with repeated use [4]. Toothbrushes are more likely to become contaminated in moist environments because they are typically kept in bathrooms, where even little drops from the toilet can unleash millions of germs into the air. The most common species found in toothbrushes kept in the restroom was *Streptococcus*, which was followed by *Pseudomonas*, *Enterococcus*, and *Neisseria* [5].

Persistent usage of toothbrushes leads to the development of biofilms in the toothbrushes that may include a variety of oral bacteria, viruses, and fungi in addition to contaminants from the environment, which transfer via the brush's storage container, contaminated hands, skin commensals, and aerosols. Some of the microbes that cause

contamination include *Streptococcus*, *Staphylococcus*, *Lactobacilli*, *Pseudomonas*, *Klebsiella*, *Escherichia coli*, and *Candida* [6,7].

Contaminated toothbrushes may be a significant contributor to a variety of systemic and oral diseases, including septicaemia, and diseases of the gastrointestinal, circulatory, pulmonary, and renal systems [8]. Cobb CM stated that toothbrushes led to repeated infections in the mouth in the early 20<sup>th</sup> century [9]. Many factors, such as the prolonged microbial survival in toothbrushes from two days to one week [10], insufficient storage, and toothbrush use without decontamination result in bacterial retention on toothbrushes and further the oral cavity can be inoculated from a contaminated toothbrush, and the untimely changing of the toothbrush with new ones may result in the repeated entry of potential pathogens and crossed infection in the oral cavity, especially in children, elderly people, those with the concomitant somatic disease, patients with high-risk i.e., immunocompromised ones, those with transplanted organs or oncologic patients [11].

Various methods of toothbrush disinfection have been investigated which include washing, soaking in alcohol, submerging in a disinfectant, spraying antimicrobial solutions on brush ends, using a microwave, and utilising an ultraviolet light. Additionally, it is advised to dry toothbrushes in the sun, use table salt to absorb moisture,

and store the brush in a closed container with a formaldehyde containing product [12].

Though a literature search reveals several publications comparing the various techniques of toothbrush disinfection, there is very little evidence exploring dental student's knowledge of toothbrush contamination, disinfection procedures, or suitable toothbrush storage methods [1,4]. This study aimed to assess undergraduate dental students' knowledge and practice about toothbrush contamination and disinfection in Chengalpet district, Tamil Nadu, India.

## MATERIALS AND METHODS

A cross-sectional study was conducted to evaluate undergraduate dental students' knowledge and practice about toothbrush contamination and disinfection in Karpaga Vinayaga Institute of Dental Sciences, Chengalpet district, Tamil Nadu, India, from January 2023 to June 2023. The study comprised third year, final year students, and interns. The Institutional Review Board provided its approval to the study protocol before the start of the study (IEC NO: KIDS/IEC/2023/III/004). The participants' anonymity was protected throughout the study. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) initiative was used as a framework for the study [13].

**Inclusion and Exclusion criteria:** The study only included students who were present during the period allotted for data collection. First-year, second-year undergraduates, and postgraduate students were excluded from the study since the students entering clinical posting were considered as part of the study. Students who refused to take part in the study were also excluded from the study.

**Sample size calculation:** A pilot study was conducted among 50 undergraduates and interns to check the feasibility of the study. Considering 50% knowledge (obtained from the pilot study) of toothbrush contamination, 80% statistical power,  $\alpha=0.05$ , 95% confidence interval, and 10% margin of error (E), the sample size was determined using G power software v.3.1. The sample size was calculated to be 232 participants, including dental students pursuing graduation. Four dental colleges were chosen by simple random sampling from a list of those in Chengalpet, Tamil Nadu, India that was taken from the DCI's official website. A total of 232 individuals, comprising third-year undergraduates to interns, were also randomly picked.

## Study Procedure

Data collection was scheduled for the month of March 2023. The students were informed about the aim of the study. Data was collected using a self-administered questionnaire.

**Survey instrument:** The previous evidence was used for generating a 16-item questionnaire [14,15]. The Cronbach's alpha, which was used to assess internal consistency, was found to be 0.73. The questionnaire contains three sections. Demographic information, including name, age, gender, and level of education, was included in the first part. A total of 16 questions covering knowledge and practice relating to toothbrush disinfection and contamination made up the second section. The student's knowledge was evaluated using the first eight questions. The practice of cleaning toothbrushes was evaluated by the following eight questions. A google form link was sent to all the study participants which contained the demographic data followed by questionnaire of the study and the responses were collected in a stipulated time. {docs.google.com/forms/u/0/d/e/1FAIpQLSc7a7rqJ34nhjYP8QiID5ZwldFp1-uJlf2Wx\_WOIBsyepb9Ww/viewform?vc=0&c=0&w=1&flr=0&usp=mail\_form\_link&usp=embed\_facebook&pli=1}. The knowledge and practice questions were scored using the following criteria: 1 for "don't know," 2 for "incorrect answer," and 3 for "correct answer." The mean score was then computed for analysis.

## STATISTICAL ANALYSIS

The Statistical Package for the Social Sciences (SPSS) for Windows version 20.0 software (IBM, Chicago Inc., IL, and USA) was used to analyse the data following the time it had been initially collected in a Microsoft Excel spreadsheet. Demographic variables were subjected to descriptive statistics. For intergroup comparison, inferential statistics were performed using the Kruskal-Wallis test. A p-value  $<0.05$  was regarded as statistically significant for all analyses.

## RESULTS

Among the 232 participants enrolled, 36 (15.5%) were male and 196 (84.4%) were female. Third year students constituted 87 (37.5%) of the participants overall, fourth year students made up 85 (36.6%) and interns accounted for 60 (26%).

The mean score for the assessment of knowledge based questions administered to these three groups was  $17.55 \pm 3.99$ ,  $17.79 \pm 3.01$ , and  $17.42 \pm 3.26$  or third year, fourth year students and interns respectively. The results showed that there was no statistically significant difference in knowledge of toothbrush contamination among the three groups ( $p=0.806$ ). In all three study groups, most of the respondents listed bacteria, fungi, and viruses as the leading causes of toothbrush contamination [Table/Fig-1]. Both fourth year students about 62 members (75%) and interns about 45 participants (73%) concurred that microorganism such as *E. coli*, *Streptococcus*, *Staphylococcus*, *Lactobacilli*, and *Candida* are responsible for contaminated toothbrushes [Table/Fig-2].

Year of study	Mean $\pm$ SD	Standard error	Confidence interval for the mean		p-value
			Lower bound	Upper bound	
Third year	17.55 $\pm$ 3.993	0.428	16.70	18.40	0.806
Final year	17.79 $\pm$ 3.016	0.327	17.14	18.44	
Interns	17.42 $\pm$ 3.269	0.422	16.57	18.26	

**[Table/Fig-1]:** Distribution of study participants according to their knowledge about toothbrush contamination and disinfection.  
Kruskal-Wallis test; p-value  $<0.05$  - statistically significant

Questions	III Year	IV Year	Interns
<b>How does toothbrush get contaminated?</b>			
a) Oral cavity	6 (6.8%)	3 (3.5%)	0 (0%)
b) Hands	0 (0%)	1 (1.1%)	1 (1.6%)
c) Aerosol contamination	5 (5.7%)	2 (2.3%)	2 (3.3%)
d) Storage containers	5 (5.7%)	3 (3.5%)	3 (5%)
e) All the above	71 (81.6%)	76 (89.4%)	54 (90%)
<b>Microorganisms capable of causing toothbrush contamination?</b>			
a) Bacteria	29 (33.3%)	27 (31.7%)	26 (43.3%)
b) Fungi	2 (2.2%)	7 (8.2%)	1 (1.6%)
c) Viruses	1 (1.1%)	2 (2.3%)	0 (0%)
d) None of the above	0 (0%)	0 (0%)	0 (0%)
e) All of the above	55 (63.2%)	49 (57.6%)	33 (55%)
<b>Common microorganisms responsible for toothbrush contamination</b>			
a) <i>E.coli</i> , <i>Streptococcus</i> , <i>Staphylococcus</i> , <i>Lactobacilli</i> , <i>Candida</i>	59 (67.8%)	62 (72.9%)	45 (75%)
b) <i>Clostridium</i> , <i>Listeria</i> , <i>Salmonella</i> , <i>Shigella</i> , <i>Bifidobacteria</i>	6 (6.8%)	8 (9.4%)	3 (5%)
c) None of the above	0 (0%)	2 (2.3%)	0 (0%)
d) All the above	22 (25.2%)	13 (15.2%)	12 (20%)
<b>Mode of transmission of infection from toothbrush?</b>			
a) Sharing the same toothbrush holder	6 (6.8%)	1 (1.1%)	5 (8.3%)
b) Sharing toothpaste	2 (2.2%)	3 (3.5%)	1 (1.6%)
c) Using the same toothbrush	41 (47.1%)	25 (29.4%)	11 (18.3%)
d) All the above	38 (43.6%)	56 (65.8%)	43 (71.6%)

Are you aware of special solutions used for toothbrush maintenance?			
a) Yes	51 (58.6)	43 (50.5)	29 (48.3)
b) No	36 (41.3)	42 (49.3)	31 (51.6)
Pick the solutions used for toothbrush maintenance			
a) 3% hydrogen peroxide	15 (17.2)	13 (15.2)	12 (20%)
b) Chlorhexidine	14 (16%)	13 (15.2)	11 (18.3%)
c) Hotwater	17 (19.5)	14 (16.4)	8 (13.3%)
d) All of the above	40 (45.9)	38 (44.7)	24 (40%)
e) None of the above	1 (1.1%)	7 (8.2%)	5 (8.3%)
Are you aware of herbal disinfectants available in home regimens which acts as an antimicrobial agent			
a) Yes	66 (75.8)	61 (71.7)	40 (66.6)
b) No	21 (24.1)	24 (28.2)	20 (33.3)
Pick the most effective herbal disinfectant among the below mentioned ones			
a) Turmeric water	41 (47.1)	41 (48.2)	26 (43.3)
b) Chinnamon water	10 (11.4%)	12 (14.1)	3 (5%)
c) Tulsi water	4 (4.5%)	5 (5.8%)	4 (6.6%)
d) Salt water	32 (36.7)	27 (31.7)	27 (45%)

**[Table/Fig-2]:** Responses of study subjects based on knowledge about toothbrush contamination and disinfection.

The mean score for the assessment of practice based questions administered to these three groups was 15.09±0.30 for third year students, 15.01±2.93 for fourth year students, and 15.47±2.74 for interns. The results show that there was no statistically significant difference in the methods used to disinfect toothbrushes between the three groups ( $p=0.613$ ) [Table/Fig-3].

Year of study	Mean±SD	Standard Error	Confidence interval for the mean		p-value
			Lower bound	Upper bound	
Third year	15.09±2.815	0.302	14.49	15.69	0.613
Final year	15.01±2.930	0.318	14.38	15.64	
Intern	15.47±2.746	0.355	14.76	16.18	

**[Table/Fig-3]:** Distribution of student responses according to their practice regarding toothbrush contamination and disinfection.  
Kruskal-Wallis test; p-value <0.05 - statistically significant

Most of them chose all three options (3% hydrogen peroxide, chlorhexidine as the best toothbrush disinfection approach, followed by plain water) for solutions used for toothbrush maintenance [Table/Fig-2]. About 46.6% were not aware of special solutions available for disinfection. About 47% of students said that turmeric water may be an option when asked about herbal disinfectants [Table/Fig-2], followed by 37.5% who said that salt water was the simplest solution for cleaning toothbrushes [Table/Fig-2]. In all three groups, a significant number of people (34%) kept their toothbrushes in toothbrush holders that were outside of the restroom [Table/Fig-4]. A nearly equal number of participants from each group used a brush cap and stored it in a toothbrush holder either in a vertical position [Table/Fig-4].

Questions	III Year	IV Year	Interns
What is the mode of rinsing your toothbrush?			
a) Hotwater	25 (28.7%)	19 (22.3%)	7 (11.6%)
b) Tapwater	36 (41.3%)	51 (60%)	42 (70%)
c) Saltwater	17 (19.5%)	5 (5.8%)	3 (5%)
d) Disinfectant solution	9 (10.3%)	10 (11.7%)	7 (11.6%)
Do you use mouthwash solution to disinfect the toothbrush?			
a) Yes	43 (49.4%)	29 (34.1%)	22 (36.6%)
b) No	44 (50.5%)	56 (65.8%)	38 (63.3%)
If yes how?			
a) Rinsing	62 (71.2%)	55 (64.7%)	41 (68.3%)

b) Sinking	19 (21.8%)	19 (22.3%)	10 (16.6%)
c) Spraying	6 (6.8%)	11 (12.9%)	8 (13.3%)
Where do you keep the toothbrush?			
a) Toothbrush box outside the bathroom	23 (26.4%)	24 (28.2%)	23 (38.3%)
b) Toothbrush box inside the bathroom	14 (16%)	10 (11.7%)	7 (11.6%)
c) Toothbrush holder Inside the bathroom	22 (25.2%)	16 (18.8%)	13 (21.6%)
d) Toothbrush holder outside the bathroom	28 (32.1%)	35 (41.1%)	17 (28.3%)
How do you store the toothbrush?			
a) Head Covered	58 (66.6%)	39 (45.8%)	23 (38.3%)
b) Without head covered	29 (33.3%)	46 (54.1%)	36 (60%)
What is the placement of your toothbrush?			
a) Vertical	71 (81.6%)	65 (76.4%)	50 (83.3%)
b) Horizontal	16 (18.3%)	20 (23.5%)	10 (16.6%)
Reason for you to replace the toothbrush with a new one			
a) Toothbrush bristles are wornout	19 (31.6%)	36 (42.3%)	19 (31.6%)
b) Broken toothbrush	1 (1.6%)	5 (5.8%)	1 (1.6%)
c) Colour change in toothbrush	2 (3.3%)	2 (2.3%)	2 (3.3%)
d) Periodical change of the toothbrush	45 (51.7%)	42 (49.4%)	38 (63.3%)
Do you advise your patients regarding toothbrush storage and disinfection?			
a) Yes	80 (91.9%)	69 (81.1%)	45 (75%)
b) No	7 (8%)	16 (18.8%)	15 (25%)

**[Table/Fig-4]:** Responses of study participants based on practice toward toothbrush disinfection.

## DISCUSSION

Toothbrushes are widely available and play a vital role in maintaining dental hygiene in both public and medical settings. Toothbrushes may have a significant effect on the propagation of illness and increase the risk of infection since they can serve as a reservoir for germs in healthy, ill, and orally sick persons [16]. Microorganisms that are prevalent in the oral cavity and elsewhere in the body may taint toothbrushes. The toothbrush's section where the tufts are anchored is particularly vulnerable to severe pollution [7]. Capillary motion can suck liquids and food particles into the gaps between tufts; this could promote bacterial development [17]. Additionally, the bristles separate longitudinally, worsening the bacterial infection. So, cleaning your toothbrush thoroughly is crucial to stopping the formation of bacteria. Therefore, the present study was conducted to assess the knowledge about toothbrush contamination and disinfection among dental students in Chengalpet district.

There was no statistically significant difference in the three groups' knowledge regarding toothbrush contamination, according to the study's findings. Most dental students have little knowledge about toothbrush contamination and disinfection, according to knowledge scores. This is consistent with the findings of a prior study by Pecker I et al., who reported that many of the participants had little awareness of toothbrush disinfection [18]. This can be explained by the possibility that toothbrush contamination is not given sufficient importance in the dentistry curriculum and that researchers instead focus on studies about serious illnesses and toothbrush contamination and disinfection is usually neglected. This conclusion conflicts with that of Barma MD et al., who found that most of the survey respondents knew sufficient about toothbrush contamination and disinfection [19].

In all three groups, around 70% of the participants comprehended that the primary sources of toothbrush contamination were bacteria, including E.Coli, Streptococcus mutans, Staphylococcus, Lactobacillus, and candida. Nonetheless, compared to the other two categories, the proportion appeared to be larger among interns 45 (75%). Studies have demonstrated that these microbes are the main cause of bacterial toothbrush contamination [6,7]. According to the majority of study participants in both the



preclinical and clinical groups and all of the interns, sharing the same toothbrush, toothpaste, and toothbrush holder is a major source of contamination. Most of the participants in this study believed that the most frequent sources of contamination were toothbrush contact with other toothbrushes that were exposed to the outside environment. This result was consistent with Sowmiya KR et al., [15].

The results of the study showed that most participants about 80.2% kept their toothbrushes in a vertical position. About 44.1% reported placing it in a toothbrush holder inside the bathroom. More than half of the study population, that is about 52.6% indicated their practice of storing toothbrushes is with the head being covered. According to Frazelle MR et al., toothbrush bristles are an area where bacteria adhere and proliferate easily [4]. Additionally, they claim that the practice of covering the toothbrush's head and leaving it in the bathroom encourages the growth of bacteria [4,5]. To prevent cross-contamination, the American Dental Association suggests keeping your toothbrush upright and out of the way of other toothbrushes [20]. Brush contamination is influenced by several variables, including toothbrush position, storage conditions, reintroduction of germs into the oral cavity, and cross-infection.

More than half of the study population was aware of special solutions available for toothbrush maintenance (53.4%). Of these 44% of them reported 3% hydrogen peroxide, chlorhexidine, and hot water to be the effective solutions used for toothbrush maintenance. Numerous studies indicate that the bacterial burden in the toothbrush can be reduced by disinfecting it using UV light, chemicals, or natural means [21-23]. Chlorhexidine has been identified as the most effective antibacterial agent by numerous investigations [24-26]. Certain studies have concluded herbal disinfectants such as neem, green tea, and garlic are equally effective as chlorhexidine in acting as an antimicrobial agent [27]. When asked about possible herbal disinfectants, around 47% of students suggested turmeric water, whereas 37.5% suggested salt water as a relatively simple toothbrush disinfectant. Based on the findings of Bhat PK et al., and Kim JE et al., turmeric solution has proven to be an effective antibacterial and demonstrated reduction in *S. mutans* growth in oral bacterial biofilms in the toothbrush [28,29].

In the present study, more than half of the participants neither practiced nor recommended toothbrush disinfection, which is a glaring sign of insufficient understanding or practical application in daily life. The dental interns should pay more attention to using proper toothbrush disinfection techniques and giving their patients advice as part of oral hygiene guidelines as they are aspiring dentists.

### Limitation(s)

The study has a few limitations that can be applied. Due to social desirability biases and inherent questionnaire design biases, this study's generalisability is limited. When answering the questions, the interns and students might not be completely honest this could result in social desirability bias. Due to the cross-sectional study design and lack of an assessment of temporality, the results should be interpreted with some caution. For a better knowledge of the opinions and behaviours of dental students and interns throughout a wide geographic area, additional research is advised. The study revealed that the knowledge of toothbrush contamination and disinfection is lacking in dental students. There should be an instructional segment on how to disinfect toothbrushes in the curriculum and ought to be used regularly.

### CONCLUSION(S)

According to the study results all the dental students possessed only limited knowledge. However, interns and final-year students seemed to have knowledge comparable to that of the third year; this may be because of their ongoing exposure to academics. Additionally, dental interns although not statistically significant, showed better

practice in toothbrush disinfection, which may be because of more clinical exposure. The present research highlights that the dental interns had a better practice in toothbrush maintenance by utilising both commercial solutions and natural disinfectants. But, no statistically significant difference was found between the students. As a result, it should be mandated that dental students learn more about this, as their training and experience may enable them to mandate it to their patients, further promoting improved oral hygiene.

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PARTICULARS OF CONTRIBUTORS:

1. Student, Department of Public Health Dentistry, Karpaga Vinayaga Institute of Dental Sciences, Madhuranthakam, Tamil Nadu, India.
2. Reader, Department of Public Health Dentistry, Karpaga Vinayaga Institute of Dental Sciences, Chengalpet, Tamil Nadu, India.
3. Professor and Head, Department of Public Health Dentistry, Karpaga Vinayaga Institute of Dental Sciences, Chengalpet, Tamil Nadu, India.
4. Assistant Professor, Department of Public Health Dentistry, Karpaga Vinayaga Institute of Dental Sciences, Madhuranthakam, Tamil Nadu, India.
5. Reader, Department of Public Health Dentistry, Karpaga Vinayaga Institute of Dental Sciences, Chengalpet, Tamil Nadu, India.
6. Assistant Professor, Department of Public Health Dentistry, Karpaga Vinayaga Institute of Dental Sciences, Madhuranthakam, Tamil Nadu, India.

**NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:**  
AB Anu,  
Student, Department of Public Health Dentistry, Karpaga Vinayaga Institute of Dental Sciences, Madhuranthakam, Tamil Nadu, India.  
E-mail: anuarjunan24@gmail.com

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ANNEXURE 1

The 16-item questionnaire utilised for this study.

Question number	III years N (%)	IV years N (%)	Interns N (%)
Question 1 How does tooth brush get contaminated? (Oral cavity, Hands, Aerosol contamination, Storage containers, All the above)	71 (81.6%)	76 (89.4%)	54 (90%)
Question 2 What are the micro-organisms capable of causing toothbrush contamination? (Bacteria)	29 (33.3%)	27 (31.7%)	26 (43.3%)
Question 3 what are the common micro organisms responsible for tooth brush contamination? (E.coli, Streptococcus, Staphylococcus, Lacto bacilli, candida)	59 (67.8%)	62 (72.9%)	45 (75%)
Question 4 What is the mode of Transmission of infection from toothbrush? (Sharing the same toothbrush holder, Sharing toothpaste, Using the same tooth brush, All the above)	38 (43.6%)	56 (65.8%)	43 (71.6%)
Question 5 Are you aware of special solutions used for toothbrush maintenance? (Yes)	51 (58.6%)	43 (50.5%)	29 (48.3%)
Question 6 Pick the solutions used for toothbrush maintenance (3% hydrogen peroxide, Chlorhexidine, Plain water, All of the above)	40 (45.9%)	38 (44.7%)	24 (40%)

Question 7 Are u aware of herbal disinfectants available in home regimens which acts as an antimicrobial agent (Yes)	66 (75.8%)	61 (71.7%)	39 (65%)
Question 8 Pick the most effective herbal disinfectant among the below mentioned ones (Turmeric water )	41 (47.1%)	41 (48.2%)	26 (43.3%)
Question 9 What is the mode of rinsing your toothbrush? (Disinfectant solution)	9 (10.3%)	10 (11.7%)	7 (11.6%)
Question 10 Do you use mouthwash solution to disinfect the toothbrush? (Yes)	43 (49.4%)	29 (34.1%)	22 (36.6%)
Question 11 If yes how? (Sinking)	19 (21.8%)	19 (22.3%)	10 (16.6%)
Question 12 Where do you keep the toothbrush? (Toothbrush holder outside the bathroom)	28 (32.1%)	35 (41.1%)	17 (28.3%)
Question 13 How do you store the toothbrush? (Without head covered)	29 (33.3%)	46 (54.1%)	36 (60%)
Question 14 What is the placement of your toothbrush? (Vertical)	71 (81.6%)	65 (76.4%)	50 (83.3%)
Question 15 Reason for you to replace the toothbrush with a new one (Periodical change of the toothbrush)	45 (51.7%)	42 (49.4%)	38 (63.3%)
Question 16 Do you advise your patients regarding toothbrush storage and disinfection? (Yes)	80 (91.9%)	69 (81.1%)	45 (75%)