Knowledge, attitudes, and behaviors (KAB) related to brushing teeth with powered toothbrush among doctors: a cross-sectional study

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Abstract

Background This study was to explore the knowledge, attitudes, and behaviors (KAB) regarding brushing teeth with powered toothbrush among doctors.

Methods This population-based, cross-sectional study was conducted by using a self-administered questionnaire regarding powered toothbrush based on the KAB model. Multistage cluster sampling was used to enrol doctors.

Results A total of 403 doctors were included in the study. The proportion of “need to be strengthen” on knowledge, attitude and behaviors was 68.0 percent, 71.0 percent and 80.4 percent, respectively. The usage rate of powered toothbrush was low in doctors (12.2 percent). Doctors from dental department had higher knowledge (p<0.001) and attitude (p<0.01) scores than the doctors from non-dental department. Doctors from the district with a higher gross regional product had higher knowledge (p<0.01) and behaviors score (p<0.001), and doctors from higher-level hospitals had higher knowledge (p<0.001). Using powered toothpaste was positively associated with the knowledge (p<0.001), attitude (p<0.05) and behaviors (p<0.001) scores.

Conclusions The majority of doctors’ knowledge, attitude and behaviors regarding powered toothbrush were needed to be strengthened. Specific health education is needed to improve the knowledge, attitude and behaviors regarding powered toothbrush.

Background

As oral diseases which seriously affect human health and quality of life, periodontitis, dental caries and gingivitis are prevalent in the world \(^{1-2}\). And for China, according to the fourth Chinese Oral Health Epidemiological Survey, more than eighty percent of adults had different degrees of periodontal diseases, the periodontal condition of middle-aged or old people decreased obviously, and the prevalence rate of caries in children was increased
Bacteria can adhere to the surface of hard or soft tissues in the oral cavity, and these common oral diseases are mainly caused by bacterial factors. The presence of dental plaque (biofilm) is a necessary condition for the occurrence of dental caries, the teeth with plaque buildup were about 14.5 times more likely to develop dental caries than teeth without dental plaque. Besides, if the population with periodontitis cannot control the dental plaque effectively, the situation of periodontitis will continue to deteriorate, which may lead to the failure of periodontal treatment, and eventually lead to tooth loss. Several studies and clinical trials have demonstrated that plaque removal was the key to maintaining long-term health of dental tissue and periodontal tissues, therefore, the successful prevention of caries and periodontitis should be achieved by the effective removal of dental plaque.

Tooth brushing is the most important way to remove dental plaque and prevent caries, gingivitis or periodontitis, and toothbrush is the most widely used tool to clean the plaque in the oral cavity. According to the source of power, the toothbrush can be divided into manual toothbrush and powered toothbrush. Although these two types of toothbrushes can achieve the same purposes, such as the removal of plaque and debris or food residue, several evidence-based studies have shown that powered toothbrushes were significantly better than manual toothbrushes in the efficiency of plaque cleaning and the short-term or long-term prevention of gingivitis, and powered toothbrushes could be safely used without detailed guidance.

Children may lack motivation, compliance, and adequate manual dexterity with respect to toothbrushing, and when combined with a higher likelihood of sugary/erosive drink
consumption, the challenges of cleaning in a mixed dentition and the risk of gingivitis and caries can be notably high \textsuperscript{21-22}. Fortunately, the good news is that powered toothbrush was also proved to have greater plaque reduction benefit than the manual toothbrush in children. \textsuperscript{22-23} Moreover, A growing number of studies have shown that many systemic diseases, such as respiratory disease, diabetes, rheumatoid arthritis, chronic kidney disease, obesity and cancer, were closely related to oral microorganism \textsuperscript{24-26}, therefore, better tooth brushing does not only contribute to the prevention of oral diseases, but also benefit the overall health. A certain number of studies have investigated the cognition or use of toothpaste among the public \textsuperscript{27-30}, however, to our knowledge, little is known about the cognition or use of powered toothbrush and no studies have focused on the levels of knowledge, attitude and behaviors regarding brushing teeth with powered toothbrush among the public. As the directors of medical work and health education, doctors’ knowledge, attitude and behaviors towards health issues will vastly influence the public \textsuperscript{31-32}, therefore, the object of this study is the doctor.

Health survey can provide information and evidence for the promotion of public health \textsuperscript{33}. Therefore, the purpose of this study is to describe the knowledge, attitude and behaviors of doctors towards brushing teeth with powered toothbrush and provide some information for health education and further studies.

\textbf{Methods}

\textbf{Participants}

This cross-sectional study was conducted in Chongqing, China, from July to August in 2017, using multistage cluster sampling method to enroll participants. The 40 districts or counties of Chongqing are divided into five levels, according to the gross regional product of 2016. In the first stage of sampling, one district or county from each of the five levels
was randomly chosen, and finally, Yuzhong, Banan, Qijiang, Fengdu, and Wulong were chosen. In the second stage of sampling, one town or block were selected randomly from each of the five districts or counties chosen in the first stage. All the dentists and non-dental dentists (NDDs) from all the legal hospitals or clinics in the selected towns or blocks were asked if he or she would like to participate in the study. A total of 437 doctors were asked if they would like to participate the study, of whom 403 doctors (243 doctors were from non-dental departments and 160 were dentists) completed the questionnaires.

**Study design**

The self-administered questionnaire was particularly designed for the study population (doctors) based on the knowledge-attitude-behavior (KAB) model, it included four parts: (1) Demographic characteristics (2) Knowledge related to brushing teeth with powered toothbrush (3) Attitude related to brushing teeth with powered toothbrush (4) Behaviors related to brushing teeth with powered toothbrush. Prior to the implementation of this study, the questionnaire was piloted with 37 doctors (15 dentists and 22 non-dental doctors), revisions were made accordingly, and after the repeated discussions with experts in epidemiology and stomatology, the final version of the questionnaire had acceptable content validity. And the internal consistency of the KAB questionnaire was acceptable (Cronbach’s alpha = 0.910).

The knowledge part of powered toothbrush was assessed by 6 single-choice questions, about the knowing of powered toothbrush and its effects on tooth brushing. Each question was assigned a score of 1, and the total score for this part ranged from 0 to 6, a high score indicates a higher level of knowledge on the topic. Example of the questions included: “Do you think that powered toothbrush can clear plaque more effectively, compared with manual toothbrush”?
The attitude part of was assessed by 3 single-choice questions on the attitudes of using and recommending powered toothbrush. Each question consisted of three levels with a score ranging from 0 to 2, which imply “certainly not” (score=0), “maybe” (score=1), and “Sure” (score=2). The total score for this item may range from 0 to 6, and a high score indicates a good attitude towards recommending powered toothbrush. Example of the questions included: “Would you like to recommend powered toothbrushes to others”? Behaviors regarding powered toothbrush was assessed by 4 single-choice questions on the used and the recommendation powered toothbrush. Each question was assigned a score of 1, and the total score for this part ranged from 0 to 4. A high score indicates a good behavior regarding brushing teeth with powered toothbrush. Example of the questions included: “Are you using powered toothbrush to brush your teeth everyday”? The scores of knowledge, attitude and behaviors were classified into two levels: “need to be strengthen” (≤60 percent) and “satisfactory” (>60percent). The study was performed in accordance with the World Medical Association Declaration of Helsinki and ethics approval was obtained from the Ethical Committee of the Chongqing Medical University. The participation of the respondents was voluntary, and they were included in the study after submitting signed informed consent.

**Quality control**

The investigators were selected from dental students who were willing to participate in this study by an interview. Prior to the survey, the investigators were trained in relevant knowledge and the implementation of the survey. Only the researchers who were familiar with the objectives and methods of this study, as well as having good interview skills and the experience in dealing with potentially sensitive issues were allowed to conduct the survey. Each of the questionnaire was checked to avoid mistakes.
**Statistical analysis**

The Statistical Package for Social Sciences (SPSS) software version 19.0 (SPSS Inc., USA) was applied to analyze the data. The descriptive data were expressed as mean ± standard deviation (SD) or proportions (%). Chi-square test was performed to test the differences among the categorical variables. A p < 0.05 was considered statistically significant. Multiple linear regression analysis was used to assess the association between sociodemographic and KAB.

**Results**

**Demographic characteristics of study population.**

A total of 437 doctors were invited to participate the study, 403 valid questionnaires were acquired (from 243 doctors were from non-dental departments and 160 were dentists), the response rate was 92.2 percent. Table 1 showed the demographic characteristics of study population. (Please see Table 1.)

**KAB Scores of brushing teeth with powered toothbrush and its inter-association.**

The mean score of knowledge, attitude and behaviors was 3.6±1.4, 3.6±1.7, 1.3±0.8, respectively. The levels of KAB were classified into the two categories: “satisfactory” and “need to be strengthen”. The proportion of “need to be strengthen” on knowledge, attitude and behaviors was 68.0 percent, 71.0 percent and 80.4 percent, respectively. (Please see Table 2.)

**Usage of powered toothbrush**

The usage rate of powered toothbrush was low in doctors (12.2 percent), and no obvious
differences between various types of doctors (p>0.05). Moreover, it is noteworthy that the usage rate of powered toothbrush among dentists was not higher than that among non-dental doctors (p>0.05) (Please see Table 3.).

**Factors Associated with KAB of brushing teeth with powered toothbrush**

Table 4 showed that doctors from dental department had higher knowledge (p<0.001) and attitude (p<0.01) scores than the doctors from non-dental department, but there were no statistical significance in behaviors scores (p>0.05). Doctors from the district with a higher gross regional product had higher knowledge (p<0.01) and behaviors scores (p<0.001), and doctors from higher-level hospitals had higher knowledge scores (p<0.01). Using powered toothbrush was positively associated with the knowledge (p<0.001), attitude (p<0.05) and behaviors (p<0.001) scores. Gender and age were not associated with KAB scores (p>0.05). (Please see Table 4.)

**Discussion**

The use of powered toothbrush in accordance with the standards may be able to clean teeth more efficiently and better, especially for children with low attention to teeth, low enthusiasm for oral health maintenance, and difficulty in mastering manual brushing techniques. 36-38 Systematic reviews have demonstrated that powered toothbrush was more effective for removing plaque and reducing gingivitis. 18-19, 39 Moreover, there was no significant cause-and-effect relationship between the use of powered toothbrushes and soft tissue injury, and the reports of soft tissue injury were rare 40. The safety of using powered toothbrush was reliable, tissue damage was only a small probability of events,
and powered toothbrushes are just as safe as manual ones. 40

This study evaluated the knowledge, attitude and behaviors of doctors regarding brushing teeth with powered toothbrush. The majority of doctors did not have enough knowledge on powered toothbrush, and the usage rate of powered toothbrush was very low in doctors (Only 12.2 percent), suggesting that the cognition or use of powered toothbrush was still at a low level.

Doctors from the district with a higher gross regional product or higher-level hospitals had higher knowledge (p<0.01), probably because they had more opportunity to accept information about the advance of sciences or commercial advertising. However, although dentists tend to display better knowledge of powered toothbrush than doctors from non-dental departments, the usage rate of dentists was also very low and not higher than the usage rate of doctors from non-dental departments, suggesting that the compliance with the knowledge of powered toothbrush among dentists may be poor, probably because dentists may not be sufficiently motivated to engage the selection of toothbrush or they may not place enough emphasis on the selection of tools of tooth brushing. Individuals who were using powered had higher scores on knowledge, attitude and behaviors, suggesting that using powered toothbrush may promote the knowledge and attitude in turn, probably because the use of powered toothbrush could inspire the interest to know some relevant knowledge. The level of knowledge, attitude and behaviors of more than two third of individuals were needed to be strengthened, suggesting that health education is needed to improve the cognition of powered toothbrush.

If people follow the scientific method strictly to brush the teeth every time, using manual toothbrush can achieve good cleaning effect as well, however, studies have shown that the majority of people did not brush their teeth systematically, the plaque removal
capability of people still tend to be low \(^{41-46}\), and brushing teeth incorrectly was particularly common in children \(^{47-49}\). Moreover, it should be noted that receiving oral health instruction could improve the effect of powered toothbrush and manual toothbrush on plaque removal \(^{50}\), thus, it is necessary for the public to receive enough instructions from doctors to master the systematical skills of tooth brushing and be aware of the tools which may make tooth brushing more effective.

The limitation of this study was that validated questionnaires are rare regarding powered toothbrush, the questionnaire adopted for this study was self-designed by our team after repeated discussions with experts and a pretest. In addition, no information was available about different types of powered toothbrush, which should be considered in future studies.

**Conclusions**

The majority of doctors’ knowledge, attitude and behaviors regarding powered toothbrush were needed to be strengthened, and the usage rate of powered toothbrush was low in doctors. Specific health education is needed to improve the knowledge, attitude and behaviors regarding powered toothbrush among public, especially for doctors.

**Abbreviations**

KAB: Knowledge, attitude, and behaviors; NDDs: Non-dental dentists; SPSS: Statistical Package for Social Sciences.

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Declarations

**Competing Interest:** Author Yanhao Wang declares that he has no conflict of interest, and author Lin Jiang declares that he has no conflict of interest.

**Consent for publication:** The authors have given final approval of the version to be published.

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**Ethics approval and consent to participate:** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards." Written informed consent was obtained from all individual participants included in the study. This cross-sectional study was approved by the Ethics Committee of Chongqing Medical University (2017.06.23).

**Availability of data and materials:** The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request. For privacy reasons, however, individual data allowing for the identification of participants cannot be made available.

**Authors’ Contribution.**

The authors have made substantial contributions to conception and design of the study. Y. W. and L.J. have been involved in study design and data collection. Y.W. has been involved in and data analysis, L.J. has been involved in data interpretation, Y.W. has been involved in drafting the manuscript.
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**Tables**

*Table 1. Demographic characteristics of the study participants (N=403)*
**Table 2. Distribution of KAB on powered toothbrush (N=403)**

| Characteristics | Participants |
|-----------------|--------------|
| Gender          | n (%)        |
| Male            | 116 (28.8)   |
| Female          | 287 (71.2)   |
| Age             | n (%)        |
| < 30 years      | 238 (59.1)   |
| 30~44 years     | 103 (25.6)   |
| 45~60 years     | 50 (12.4)    |
| > 60 years      | 12 (3.0)     |
| Department      | n (%)        |
| Non-dental      | 243 (60.3)   |
| Dental          | 160 (39.7)   |
| Hospital type   | n (%)        |
| Tertiary hospitals | 126 (31.3) |
| Secondary hospitals | 162 (40.2) |
| Community hospitals | 24 (6.0)   |
| Private clinics | 91 (22.6)    |
| District        | n (%)        |
| Yuzhong         | 117 (29.0)   |
| Banan           | 68 (16.9)    |
| Qijiang         | 107 (26.6)   |
| Wulong          | 55 (13.6)    |
| Fengdu          | 56 (13.9)    |

Note: The scores of knowledge, attitude and behaviors were classified into two levels: “need to be strengthen” (≤60 percent) and “satisfactory” (>60 percent)

**Table 3. Usage of powered toothbrush (N=403)**
| Characteristics          | Use it | Not use it | $\chi^2$ | $P$  |
|-------------------------|--------|------------|----------|------|
|                         | $N1$ (%) | $N2$ (%)   |          |      |
| **Gender**              |        |            |          |      |
| Male                    | 19 (16.4) | 97 (83.6)  | 2.717    | 0.099|
| Female                  | 30 (10.5) | 287 (89.5) |          |      |
| **Age**                 |        |            |          |      |
| < 30 years              | 24 (10.1) | 238 (89.9) | 2.436    | 0.487|
| 30~44 years             | 15 (14.6) | 103 (85.4) |          |      |
| 45~60 years             | 8 (16.0)  | 50 (84.0)  |          |      |
| > 60 years              | 2 (16.7)  | 12 (83.3)  |          |      |
| **Department**          |        |            |          |      |
| Non-dental              | 30 (12.3) | 243 (87.7) | 0.020    | 0.888|
| Dental                  | 19 (11.9) | 160 (88.1) |          |      |
| **Hospital type**       |        |            |          |      |
| Tertiary hospitals      | 19 (15.1) | 126 (84.9) | 1.546    | 0.672|
| Secondary hospitals     | 17 (10.5) | 162 (89.5) |          |      |
| Community hospitals     | 3 (12.5)  | 24 (87.5)  |          |      |
| Private clinics         | 10 (11.0) | 91 (89.0)  |          |      |
| **District**            |        |            |          |      |
| Wulong                  | 3 (5.5)  | 55 (94.5)  | 7.238    | 0.124|
| Fengdu                  | 8 (14.3) | 56 (85.7)  |          |      |
| Qijiang                 | 10 (9.3) | 107 (90.7) |          |      |
| Banan                   | 7 (10.3)  | 68 (89.7)  |          |      |
| Yuzhong                 | 21 (17.9) | 117 (82.1) |          |      |

*Table 4. Multiple linear regression analysis with Demographic characteristics and KAB.*
| Variables                  | Knowledge |          |          |          |          |          |          |          |          |          |          |
|---------------------------|-----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
|                           | Beta      | SE       | p        | Beta     | SE       | p        | Beta     | SE       | p        |
| Gender d                  | 0.023     | 0.140    | 0.613    | 0.08     | 0.18     | 0.086    | 0.05     | 0.05     |          |          |
| Age b                     | -0.025    | 0.178    | 0.575    | -0.09    | 0.23     | 0.070    | -0.0     | 0.07     |          |          |
| Department c              | 0.312     | 0.133    | 0.000*   | 0.16     | 0.17     | 0.002*   | -0.0     | 0.05     |          |          |
| District d                | 0.152     | 0.046    | 0.001*   | 0.08     | 0.06     | 0.082    | 0.12     | 0.01     |          |          |
| Hospital e                | 0.150     | 0.059    | 0.002*   | 0.08     | 0.07     | 0.091    | -0.0     | 0.02     |          |          |
| Using or not f            | 0.241     | 0.190    | 0.000*   | 0.12     | 0.24     | 0.010*   | 0.75     | 0.07     |          |          |

Note: “Beta” indicates standardized partial regression coefficient; “SE” indicates standard error.  
* p < 0.05 indicates significant difference.