Associations between dental knowledge, source of dental knowledge and oral health behavior in Japanese university students: A cross-sectional study

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Abstract

The aim of this study was to investigate the associations between dental knowledge, the source of dental knowledge and oral health behavior in a group of students at a university in Japan. A total of 2,220 university students (1,276 males, 944 females) volunteered to undergo an oral examination and answer a questionnaire. The questionnaire assessed dental knowledge, the source of dental knowledge and oral health behavior (e.g., daily frequency of tooth brushing, use of dental floss and regular dental checkups). The odds ratio and 95% confidence interval for oral health behavior based on dental knowledge and source of dental knowledge were calculated using logistic regression models. Of the participants, 1,266 (57.0%) students obtained dental knowledge from dental clinics, followed by school (39.2%) and television (29.1%). Logistic regression analyses indicated that use of dental floss was significantly associated with source of dental knowledge (P = 0.006). Receiving regular dental checkups was significantly associated with source of dental knowledge; the positive source was dental clinic (P < 0.001) and the negative sources were school (P = 0.004) and television (P = 0.018). Dental clinic was the most common source of dental knowledge and associated with better oral health behavior among the Japanese university students in this study.

Introduction

In research on major chronic diseases, more emphasis has been placed on the influence of health behavior rather than standard risk factors [1]. This concept has spread to the field of
dentistry as well. In fact, oral diseases including periodontal disease can be prevented by adopting proper oral health behavior [2–4].

Proper oral health behavior such as tooth brushing, use of dental floss and receiving regular dental checkups prevents periodontal disease [5,6]. Furthermore, oral health behavior is also associated with various factors including dental knowledge [7–9], attitude [8–10], lifestyle [11–13], stress [14,15], education level [16], socioeconomic status [17,18], sense of coherence [19] and self-efficacy [5]. Among these factors, we focused on dental knowledge in a previous study and found that university students with dental knowledge practiced better oral health behavior such as use of dental floss [20].

University students are able to obtain dental knowledge through various means. For example, a television campaign as a source of dental knowledge demonstrated a significant impact on knowledge of periodontal health and disease in adults [21–23]. Another study also suggested that school is meaningful for oral health education of children as a source of dental knowledge [24]. Furthermore, dental knowledge from dental clinics may be effective at modifying oral health behavior [25–27]. Therefore, there may be effective sources of dental knowledge that contribute to oral health behavior or periodontal disease. However, few studies have reported the influence of various sources of dental knowledge on oral health behavior.

According to these results, we hypothesized that both the source of dental knowledge and dental knowledge itself correlate with oral health behavior in university students. The aim of this study was to investigate the associations between the source of dental knowledge, dental knowledge and oral health behavior in a group of students at a university in Japan.

Materials and methods

Study population

In April 2014, first-year students (n = 2,288) at Okayama University were invited in this study and 2,270 students received voluntary oral examinations and completed a questionnaire (response rate = 99.2%). The participants were recruited from 11 faculties (Faculties of Letters, Education, Law, Economics, Science, Pharmaceutical Sciences, Engineering, Environmental Science and Technology, Agriculture, Medicine and Dentistry). The inclusion criteria were young adults (18–24 years old), and students who received oral examinations and completed the questionnaire. The exclusion criteria were participants aged ≥ 25 years old and those who had provided incomplete responses in the questionnaire. Participants aged ≥ 25 years old (n = 25) and those who had provided incomplete responses in the questionnaire (n = 25) were excluded. Finally, data from 2,220 students (1,276 males, 944 females) were subjected to analysis.

Informed consent was obtained verbally from each participant. The protocol of this study was approved by the Ethics Committee of Okayama University Graduate School of Medicine, Dentistry and Pharmaceutical Sciences (No. 808).

Questionnaire

A self-administered questionnaire was delivered by postal mail to each participant before dental examinations were conducted. In addition to sex and age, the questionnaire included the following items.

Dental knowledge. Questionnaire items asked participants whether they could explain dental terms, such as calculus, dental plaque, dental floss, sealant, periodontal disease, temporomandibular disorder, fluoride-containing mouthwash, topical application of fluoride and 8020 movement [20]. “8020 movement” is a Japanese social campaign aiming to retain 20 or more of one’s own teeth at the age of 80 [28]. Answers were given in a “yes/no” format.
**Source of dental knowledge.** Participants were also requested to state where they acquired dental knowledge. Participants were able to indicate up to three sources from the following: dental clinic, school, television, family, internet, newspaper, acquaintance and publication.

**Oral health behavior.** Participants were asked about the following oral health behavior: daily frequency of tooth brushing ($\geq 2$ times/$\leq 1$ time); use of dental floss (yes/no); and receiving regular dental checkups during the past year (yes/no) [5,6].

**Oral examination**

Five dentists (D.E., A.T., S.M., M.Y-T. and K.K.) examined the participants’ periodontal status. The periodontal status was assessed using the Community Periodontal Index (CPI) [29] using a CPI probe (YDM, Tokyo, Japan) to evaluate six sites on each tooth (mesio-buccal, mid-buccal, disto-buccal, disto-lingual, mid-lingual and mesio-lingual). For periodontal examination, the following 10 teeth were selected: two molars in each posterior sextant and the upper right and lower left central incisors. As bleeding on probing (BOP) is an earlier and more sensitive indicator of gingival inflammation than the probing depth [30], the percentage of teeth exhibiting BOP (%BOP) among the ten examined teeth was also assessed [20]. The intra- and inter-examiner reliabilities, evaluated by $\kappa$ statistics, of the CPI score were $> 0.8$.

**Statistical analyses.** The unpaired $t$ test and chi-squared test were used to determine significant differences according to sex. Secondly, the chi-squared test was used to determine significant differences according to oral health behavior.

The odds ratio (OR) and 95% confidence interval (CI) were calculated using a logistic regression model. Each oral health behavior was considered a dependent variable. The multivariate analysis included sex, age, dental knowledge and the source of dental knowledge as independent variables. Independent variables were selected when the $P$ value was $<0.05$ for the chi-square test or unpaired $t$-test in each variable.

Lastly, we evaluated the significant differences in oral health behavior between the two groups of periodontal statuses using the chi-squared test. The CPI and %BOP were divided into the following two groups: presence of probing pocket depth (PPD) $\geq 4$ mm (CPI codes 0, 1 or 2 vs. CPI codes 3 or 4) or %BOP ($< 20$ vs. $\geq 20$) [31].

All statistical analyses were performed using SPSS (version 22.0; IBM, Tokyo, Japan) with a level of significance set at $P < 0.05$.

**Results**

Table 1 shows the differences in parameters between males and females. Males had worse oral health behavior than females ($P < 0.01$). Additionally, males had significantly less dental knowledge of the seven terms than females ($P < 0.05$). More than half of the students acquired dental knowledge from a dental clinic, followed by school and television. In contrast, newspaper, acquaintance and publication were rarely chosen as the source of dental knowledge.

There were no significant differences in dental knowledge and source of dental knowledge between the two groups of tooth brushing frequency (Table 2). There were significant differences in dental knowledge of calculus, dental floss and sealant according to use of dental floss and receiving regular dental checkups ($P < 0.05$). Participants who acquired dental knowledge from a dental clinic reported significantly greater use of dental floss and regular dental checkups than participants who did not ($P < 0.05$) However, participants who acquired dental knowledge from school or television reported significantly lower use of dental floss and regular dental checkups than participants who did not ($P < 0.05$).
Regarding the association between oral health behavior and dental knowledge or source of dental knowledge, the parameters that showed the significant differences in oral health behavior were partially different between males and females (Tables 3 and 4).

In logistic regression analyses, daily frequency of tooth brushing was significantly associated with sex \((P < 0.001)\) (Table 5). Use of dental floss was significantly associated with sex \((P = 0.004)\); having knowledge of dental floss \((P < 0.001)\) and sealant \((P = 0.048)\); and dental clinic as the source of dental knowledge \((P = 0.006)\). Regular dental checkups were significantly associated with sex \((P = 0.006)\), having knowledge about dental plaque \((P = 0.008)\), calculus \((P < 0.001)\), dental floss \((P = 0.016)\) and sealant \((P = 0.008)\), and the source of dental knowledge \((P < 0.05)\). The positive source was dental clinic \((P < 0.001)\) and the negative sources were school \((P = 0.004)\) and television \((P = 0.018)\).

The association between oral health behavior and periodontal status is shown in S1 Table. Participants with low %BOP scores \(< 20\%) had significantly higher frequencies of using dental floss and regular dental checkups than participants with higher %BOP scores \(\geq 20\%) \((P < 0.001)\) (S1 Table).

### Table 1. Differences in parameters between males and females.

|                                | Males  | Females | Total   | \(P\) value a |
|--------------------------------|--------|---------|---------|---------------|
|                                | \(n = 1,276\) | \(n = 944\) | \(n = 2,220\) |               |
| Age                            | 18.4 (0.7) | 18.3 (0.7) | 18.4 (0.7) | 0.009         |
| **Oral health behavior**       |        |         |         |               |
| Tooth brushing (daily frequency) |        |         |         |               |
| \(\geq\) Two times            | 1,052 (82.4) | 870 (92.2) | 1,922 (86.6) | <0.001        |
| \(<\) One time                | 224 (17.6)  | 74 (7.8)  | 298 (13.4)  |               |
| Use of dental floss            | Yes    |         |         |               |
|                                | 139 (10.9) | 153 (16.2) | 292 (13.2)  | <0.001        |
| Regular dental checkups        | Yes    |         |         |               |
|                                | 182 (14.3) | 197 (20.9) | 379 (17.1)  | <0.001        |
| **Dental knowledge**           |        |         |         |               |
| Dental plaque                  |        |         |         |               |
|                                | Yes    |         |         |               |
|                                | 433 (33.9) | 347 (36.8) | 780 (35.1)  | 0.168         |
| Calculus                       |        |         |         |               |
|                                | Yes    |         |         |               |
|                                | 364 (28.5) | 357 (37.8) | 721 (32.5)  | <0.001        |
| Periodontal disease            |        |         |         |               |
|                                | Yes    |         |         |               |
|                                | 278 (21.8) | 269 (28.5) | 547 (24.6)  | <0.001        |
| 8020 movement                  |        |         |         |               |
|                                | Yes    |         |         |               |
|                                | 217 (17.0) | 250 (26.5) | 467 (21.0)  | <0.001        |
| Temporomandibular disorder     |        |         |         |               |
|                                | Yes    |         |         |               |
|                                | 128 (10.0) | 171 (18.1) | 299 (13.5)  | <0.001        |
| Dental floss                   |        |         |         |               |
|                                | Yes    |         |         |               |
|                                | 83 (6.5)  | 115 (12.2) | 198 (8.9)   | <0.001        |
| Topical application of fluoride |        |         |         |               |
|                                | Yes    |         |         |               |
|                                | 41 (3.2)  | 50 (5.3)  | 91 (4.1)    | 0.014         |
| Fluoride-containing mouthwash  |        |         |         |               |
|                                | Yes    |         |         |               |
|                                | 26 (2.0)  | 21 (2.2)  | 47 (2.1)    | 0.762         |
| Sealant                        |        |         |         |               |
|                                | Yes    |         |         |               |
|                                | 15 (1.2)  | 25 (2.6)  | 40 (1.8)    | 0.010         |
| **Source of dental knowledge** |        |         |         |               |
| Dental clinic                  |        |         |         |               |
|                                | Yes    |         |         |               |
|                                | 687 (53.8) | 579 (61.3) | 1,266 (57.0) | <0.001        |
| School                         |        |         |         |               |
|                                | Yes    |         |         |               |
|                                | 453 (35.5) | 417 (44.2) | 870 (39.2)  | <0.001        |
| Television                     |        |         |         |               |
|                                | Yes    |         |         |               |
|                                | 383 (30.0) | 262 (27.8) | 645 (29.1)  | 0.246         |
| Family                         |        |         |         |               |
|                                | Yes    |         |         |               |
|                                | 287 (22.5) | 204 (21.6) | 491 (22.1)  | 0.621         |
| Internet                       |        |         |         |               |
|                                | Yes    |         |         |               |
|                                | 289 (22.6) | 136 (14.4) | 425 (19.1)  | <0.001        |
| Newspaper                      |        |         |         |               |
|                                | Yes    |         |         |               |
|                                | 40 (3.1)  | 37 (3.9)  | 77 (3.5)    | 0.318         |
| Acquaintance                   |        |         |         |               |
|                                | Yes    |         |         |               |
|                                | 52 (4.1)  | 23 (2.4)  | 75 (3.4)    | 0.035         |
| Publication                    |        |         |         |               |
|                                | Yes    |         |         |               |
|                                | 36 (2.8)  | 19 (2.0)  | 55 (2.5)    | 0.226         

Values are reported as mean (standard deviation) for age and number (percentage) for dichotomous variables.
aCompared males and females using t test or chi-square test.

https://doi.org/10.1371/journal.pone.0179298.t001
In this study, we focused on the associations between the source of dental knowledge, dental knowledge and oral health behavior. We found that differences in the source of dental knowledge were associated with oral health behavior in university students; that is, both positive and negative associations between the sources and oral health behavior were observed.

The source of dental knowledge from dental clinics contributed to good oral health behavior, i.e., use of dental floss and regular dental checkups. A previous study found that oral health education at dental clinics was effective at modifying oral health behavior [25–27], which was confirmed by our results. Since dentists are important sources of oral disease prevention for the general public [32], dental clinics could be the most effective location for university students to improve oral health behavior.

It is interesting to note that school and television were negatively associated with regular dental checkups (Table 5). Previous studies found that oral health education in primary or secondary school could improve oral health behavior [33–39]. On the other hand, other studies in school-based education programs found no improvement [40,41]. A mass media health education campaign on television could not demonstrate a significant impact on behavior [42,43]. Furthermore, a recent study suggests that oral health program without repetition could transiently improve oral health behavior, but could not sustain improved oral health behavior in the long-term [44]. Thus, oral health education should be repeated with either method to keep
its positive results [41,44,45]. Taken together, the other sources except for dental clinics might not encourage regular dental checkups repeatedly.

A previous study found that oral health education from school teachers or dentists was equally effective in improving oral health knowledge and the oral hygiene status of adolescents [46]. However, the outcome of oral health education programs is dependent on the teachers’ instructions or motivations [47–49]. This finding may support our result that obtaining dental knowledge from school was negatively associated with receiving regular dental checkups.

On the other hand, multifaceted interventions such as education programs, with a combination of methods (lectures and small-group discussions), improved knowledge, skills and attitude compared to single interventions or no interventions [50]. In terms of an education program, “television”, “family”, “internet”, “newspaper”, “acquaintance” or “publication” involved no intervention, but “school” can have multifaceted interventions. This study demonstrated that school was one of the major sources of dental knowledge. However, school was negatively associated with oral health behavior. Therefore, more effective intervention to promote better oral health behavior among students should be introduced in the Japanese education curriculum.

In this study, the most common source of dental knowledge was dental clinic, followed by school. However, approximately 20 years ago, schools were the most common source of dental knowledge in Japan [24]. In other countries, more than 60% of adults obtained dental knowledge from dentists or dental clinics [32, 51]. Furthermore, in the United States and other western countries, adults visited the dental clinic more often [52–54]. In Japan, the rate of regular

Table 3. Association between oral health behavior and dental knowledge or source of dental knowledge in males.

| Source of dental knowledge | Tooth brushing (daily frequency) | Use of dental floss | Regular dental checkup |
|----------------------------|----------------------------------|---------------------|------------------------|
|                            | n = 1,052                        | n = 224             | n = 139                | n = 1,137             | n = 182             | n = 1,094            |
| Dental plaque              | Yes                              | 364 (34.6)          | 69 (30.8)              | 63 (45.3)*            | 370 (32.5)          | 76 (41.8)*            | 357 (32.6)           |
| Calculus                   | Yes                              | 303 (28.8)          | 61 (27.2)              | 55 (39.6)*            | 309 (27.2)          | 84 (46.2)**           | 280 (25.6)           |
| Periodontal disease        | Yes                              | 232 (21.1)          | 46 (20.5)              | 38 (27.3)             | 240 (21.1)          | 45 (24.7)             | 233 (21.3)           |
| 8020 movement              | Yes                              | 177 (16.8)          | 40 (17.9)              | 23 (16.5)             | 194 (17.1)          | 30 (16.5)             | 187 (17.1)           |
| Temporomandibular disorder | Yes                              | 109 (10.4)          | 19 (8.5)               | 17 (12.2)             | 111 (9.8)           | 22 (12.1)             | 106 (9.7)            |
| Dental floss               | Yes                              | 65 (6.2)            | 18 (8.0)               | 18 (12.9)*            | 65 (5.7)            | 26 (14.3)**           | 57 (5.2)             |
| Topical application of fluoride | Yes                            | 35 (3.3)            | 6 (2.7)                | 6 (4.3)               | 35 (3.1)            | 11 (6.0)*             | 30 (2.7)             |
| Fluoride-containing mouthwash | Yes                        | 22 (2.1)            | 4 (1.8)                | 7 (5.0)*              | 19 (1.7)            | 8 (4.4)               | 18 (1.6)             |
| Sealant                    | Yes                              | 14 (1.3)            | 1 (0.4)                | 3 (2.2)               | 12 (1.1)            | 5 (2.7)*              | 10 (0.9)             |

Values are reported as number (percentage).

*P < 0.05
**P < 0.01, chi-square test.

https://doi.org/10.1371/journal.pone.0179298.t003
The percentage of participants who could explain dental floss was different from that of participants who used dental floss. The previous study shows that the percentage of participants who comprehend dental floss was different to that of participants who used dental floss [56]. Thus, explainable level of dental knowledge might not completely imply oral health behavior. On the other hand, dental knowledge of dental floss was positively associated with use of dental floss, which was supported by the previous study [56]. As the relationship between knowledge and behavior can be complex, further studies are needed.

In our study, use of dental floss and receiving regular dental checkups were associated with %BOP (S1 Table); that is, participants with good oral health behavior had good periodontal status. This result supports the findings of a previous study [6]. Thus, acquiring dental knowledge from dental clinics may effectively induce good oral health behavior, which contributes to achieving and maintaining good periodontal status.

There are some limitations associated with our study. First, a causal association could not be shown because the study was cross-sectional. Second, other possible confounders, such as attitude [9–10], lifestyle [11–13], stress [14,15], education level [16], socioeconomic status [17,18], sense of coherence [19] and self-efficacy [5], were not included in this study. Third, we did not investigate the effects of frequency of obtaining information from the source, interaction between the assessed knowledge and the sources, frequency of dental floss use, the recall

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| Table 4. Association between oral health behavior and dental knowledge or source of dental knowledge in females. |
|---------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|
| Tooth brushing (daily frequency)                             | Use of dental floss                                           | Regular dental checkup                                        |
| ≥Two times                                                  | <One time                                                     | Yes                                                          | No                                                          | Yes                                                          | No                                                          |
| n = 870                                                     | n = 74                                                        | n = 153                                                      | n = 791                                                     | n = 197                                                      | n = 747                                                     |
| **Dental knowledge**                                        |                                                               |                                                               |                                                             |                                                              |                                                              |
| Dental plaque                                               | Yes                                                          | 318 (36.6)                                                   | 29 (39.2)                                                   | 63 (41.2)                                                   | 284 (35.9)                                                   | 62 (31.5)                                                   | 285 (38.2)                                                   |
| Calculus                                                    | Yes                                                          | 332 (38.2)                                                   | 25 (33.8)                                                   | 68 (44.4)                                                   | 289 (36.5)                                                   | 89 (45.2)                                                   | 268 (35.9)                                                   |
| Periodontal disease                                         | Yes                                                          | 249 (28.6)                                                   | 20 (27.0)                                                   | 48 (31.4)                                                   | 221 (27.9)                                                   | 58 (29.4)                                                   | 211 (28.2)                                                   |
| 8020 movement                                               | Yes                                                          | 229 (26.3)                                                   | 21 (28.4)                                                   | 37 (24.2)                                                   | 213 (26.9)                                                   | 54 (27.4)                                                   | 196 (26.2)                                                   |
| Temporomandibular disorder                                 | Yes                                                          | 157 (18.0)                                                   | 14 (18.9)                                                   | 20 (13.1)                                                   | 151 (19.1)                                                   | 37 (18.8)                                                   | 134 (17.9)                                                   |
| **Dental floss**                                            | Yes                                                          | 106 (12.2)                                                   | 9 (12.2)                                                    | 39 (25.5)**                                                 | 76 (9.6)                                                     | 32 (16.2)                                                   | 83 (11.1)                                                   |
| Topical application of fluoride                             | Yes                                                          | 45 (5.2)                                                     | 5 (6.8)                                                     | 12 (7.8)                                                    | 38 (4.8)                                                     | 14 (7.1)                                                    | 36 (4.8)                                                    |
| Fluoride-containing mouthwash                               | Yes                                                          | 21 (2.4)                                                     | 0 (0)                                                       | 4 (2.6)                                                     | 17 (2.1)                                                     | 4 (2.0)                                                     | 17 (2.3)                                                    |
| Sealant                                                     | Yes                                                          | 23 (2.6)                                                     | 2 (2.7)                                                     | 10 (6.5)**                                                  | 15 (1.9)                                                     | 12 (6.1)**                                                  | 13 (1.7)                                                    |
| **Source of dental knowledge**                             |                                                               |                                                               |                                                             |                                                              |                                                              |                                                              |                                                              |
| **Dental clinic**                                           | Yes                                                          | 535 (61.5)                                                   | 44 (59.5)                                                   | 109 (71.2)**                                                | 470 (59.4)                                                   | 166 (84.3)**                                                | 413 (55.3)                                                   |
| School                                                      | Yes                                                          | 383 (44.0)                                                   | 34 (45.9)                                                   | 54 (35.3)**                                                 | 363 (45.9)                                                   | 58 (29.4)**                                                 | 359 (48.1)                                                   |
| Television                                                  | Yes                                                          | 236 (27.1)                                                   | 26 (35.1)                                                   | 33 (21.6)                                                   | 229 (29.0)                                                   | 42 (21.3)**                                                 | 220 (29.5)                                                   |
| Family                                                      | Yes                                                          | 188 (21.6)                                                   | 16 (21.6)                                                   | 46 (30.1)**                                                 | 158 (20.0)                                                   | 50 (25.4)                                                   | 154 (20.6)                                                   |
| Internet                                                    | Yes                                                          | 125 (14.4)                                                   | 11 (14.9)                                                   | 30 (19.6)**                                                 | 106 (13.4)                                                   | 22 (11.2)                                                   | 114 (15.3)                                                   |
| Newspaper                                                   | Yes                                                          | 35 (4.0)                                                     | 2 (2.7)                                                     | 5 (3.3)                                                     | 32 (4.0)                                                     | 4 (2.0)                                                     | 33 (4.4)                                                    |
| Acquainance                                                | Yes                                                          | 22 (2.5)                                                     | 1 (1.4)                                                     | 4 (2.6)                                                     | 19 (2.4)                                                     | 5 (2.5)                                                     | 18 (2.4)                                                    |
| Publication                                                 | Yes                                                          | 18 (2.1)                                                     | 1 (1.4)                                                     | 2 (1.3)                                                     | 17 (2.1)                                                     | 2 (1.0)                                                     | 17 (2.3)                                                    |

Values are reported as number (percentage).

*P < 0.05

**P < 0.01, chi-square test.

https://doi.org/10.1371/journal.pone.0179298.t004
interval for the dental checkups, the experience and pattern of dental visitation, or the relation between oral health status and dental visitation pattern, which might affect oral health behavior. Finally, all participants were recruited from Okayama University students. It may limit the ability to extrapolate these findings to the general young population.

**Conclusion**

The source of dental knowledge from dental clinics as well as having dental knowledge were associated with better oral health behavior in university students in Japan.

**Supporting information**

S1 Table. Association between oral health behavior and periodontal status.

(DOCX)
Acknowledgments

The authors thank Dr. Muneyoshi Kunitomo, Hirofumi Mizuno and Hisataka Miyai (Department of Preventive Dentistry, Okayama University Graduate School of Medicine, Dentistry and Pharmaceutical Sciences, Okayama, Japan) for helping with data entry.

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References

1. Kickbusch I. Life-styles and health. Soc Sci Med. 1986; 22: 117–124. PMID: 3961531
2. Davies RM, Davies GM, Ellwood RP. Prevention. Part 4: Toothbrushing: what advice should be given to patients? Br Dent J. 2003; 195: 135–141. https://doi.org/10.1038/sj.bdj.4810396 PMID: 12907975
3. Sheiham A. Dietary effects on dental diseases. Public Health Nutr. 2001; 4(2B): 569–591. PMID: 11683551
4. Sham AS, Cheung LK, Jin LJ, Corbet EF. The effects of tobacco use on oral health. Hong Kong Med J. 2003; 9(4): 271–277. PMID: 12904615
5. Mizutani S, Ekuni D, Furuta M, Tomofuji T, Irie K, Azuma T, et al. Effects of self-efficacy on oral health behaviours and gingival health in university students aged 18- or 19-years-old. J Clin Periodontol. 2012; 39(9): 844–849. https://doi.org/10.1111/j.1600-051X.2012.01919.x PMID: 22780323
6. Lang WP, Farghaly MM, Ronis DL. The relation of preventive dental behaviors to periodontal health status. J Clin Periodontol. 1994; 21(3): 194–198. PMID: 8157773
7. Deinzer R, Michealis W, Granrath N, Hoffmann T. More to learn about: periodontitis-related knowledge and its relationship with periodontal health behaviour. J Clin Periodontol. 2009; 36(9): 756–764. https://doi.org/10.1111/j.1600-051X.2009.01452.x PMID: 19659893
8. Ostberg AL, Halling A, Lindblad U. Gender differences in knowledge, attitude, behavior and perceived oral health among adolescents. Acta Odontol Scand. 1999; 57(4): 231–236. PMID: 10540935
9. Fukai K. Statistical Analysis of Cognitions of Oral Health and Acceptance of Dental Care in Japanese Adult Population. J Dent Hlth. 1998; 48(1): 120–142 (in Japanese).
10. Fukai K, Takaesu Y, Maki Y. Gender differences in oral health behavior and general health habits in an adult population. Bull Tokyo Dent Coll. 1999; 40(4): 187–193. PMID: 11933308
11. Rajala M, Honkala E, Rimpelä M, Lammi S. Toothbrushing in relation to other health habits in Finland. Community Dent Oral Epidemiol. 1980; 8(6): 391–395. PMID: 6942955
12. Harada S, Akhter R, Kurita K, Mori M, Hoshikoshi M, Tamashiro H, et al. Relationships between lifestyle and dental health behaviors in a rural population in Japan. Community Dent Oral Epidemiol. 2005; 33 (1): 17–24. https://doi.org/10.1111/j.1600-0528.2004.00189.x PMID: 15642043
Sakki TK, Knuttila ML, Anttila SS. Lifestyle, gender and occupational status as determinants of dental health behavior. J Clin Periodontol. 1998; 25(7): 566–570. PMID: 9696257

14. Aleksejuniene J, Holst D, Eriksen HM, Gjermo P. Psychosocial stress, lifestyle and periodontal health. J Clin Periodontol. 2002; 29(4): 326–335. PMID: 11966930

15. Genco RJ, Ho AW, Grossi SG, Dunford RG, Tedesco LA. Relationship of stress, distress and inadequate coping behaviors to periodontal disease. J Periodontol. 1999, 70(7), 711–723. https://doi.org/10.1902/jop.1999.70.1.100 PMID: 10440631

16. Paulander J, Axelsson P, Lindhe J. Association between level of education and oral health status in 35-, 50-, 65- and 75-year-olds. J Clin Periodontol. 2003; 30(8): 697–704. PMID: 12897338

17. Cronin AJ, Claffey N, Stassen LF. Who is at risk? Periodontal disease risk analysis made accessible for the general dental practitioner. Br Dent J. 2008; 205: 131–137. https://doi.org/10.1038/sj.bdj.2008.653 PMID: 18690185

18. Newman JF, Gift HC. Regular pattern of preventive dental services—a measure of access. Soc Sci Med. 1981; 15: 183–186. PMID: 7020724

19. Elyasi M, Abreu LG, Badri P, Saltaji H, Flores-Mir C, Amin M. Impact of sense of coherence on oral health behaviors: a systematic review. PLoS One. 2015; 10: e0133918. https://doi.org/10.1371/journal.pone.0133918 PMID: 26275064

20. Furuta M, Ikeda K, Irie K, Azuma T, Tomofuji T, Ogura T, et al. Sex differences in gingivitis relate to interaction of oral health behaviors in young people. J Clin Periodontol. 2011; 82(4): 558–565. https://doi.org/10.1902/jop.2010.100444 PMID: 20936916

21. Gholami M, Pakdaman A, Montazeri A, Jafari A, Virtanen J. Assessment of periodontal knowledge following a mass media oral health promotion campaign: a population-based study. BMC Oral Health. 2014; 14: 31. https://doi.org/10.1186/1472-6831-14-31 PMID: 24708753

22. Märtensson C, Söderfeldt B, Halling A, Renvert S. Knowledge on periodontal disease before and after a mass media campaign. Swed Dent J. 2004; 28(4): 165–171. PMID: 15779493

23. Gholami M, Pakdaman A, Montazeri A, Virtanen J. Evaluation of the impact of a mass media campaign on periodontal knowledge among Iranian adults: a three-month follow-up. PLoS One. 2017; 12(1): e0169668. https://doi.org/10.1371/journal.pone.0169668 PMID: 28060959

24. d’Almeida HB, Kagami N, Maki Y, Takaesu Y. Self-reported oral hygiene habits, health knowledge, and sources of oral health information in a group of Japanese junior high school students. Bull Tokyo Dent Coll. 1997; 38(2): 123–131. PMID: 9566129

25. Iwamoto A, Ishikawa Y, Yagi M, Ohuchi A, Sato T, Fukai K, et al. Changing patterns of behavior related to oral health in dental health examination program for adults that gives priority to risk-funding and health-guidance. J Dent Hyth. 2012; 62(1): 33–40 (in Japanese).

26. Hugoson A, Koch G, Göthberg C, Heilimo AN, Lundin SA, Nordenby O, et al. Oral health of individuals aged 3–80 years in Jönköping, Sweden during 30 years (1973–2003). I. Review of findings on dental care habits and knowledge of oral health. Swed Dent J. 2005; 29(4): 125–38. PMID: 16463569

27. Saengtipbovorn S, Taneepanchaskul S. Effectiveness of lifestyle change plus dental care (LCDC) program on improving glycemic and periodontal status in the elderly with type 2 diabetes. BMC Oral Health. 2014; 14: 72. https://doi.org/10.1186/1472-6831-14-72 PMID: 24934646

28. Ishii T. The meaning and problem of the 80:20 movement in Japan. Nihon Hotetsu Shika Gakkai Zasshi. 2014; 11(2): 126–133. https://doi.org/10.1111/jre.12233 PMID: 25142752

29. Angelopoulou MV, Oulis CJ, Kavvadia K. School-based oral health-education program using experiential learning or traditional lecturing in adolescents: a clinical trial. Int Dent J. 2014; 64(5): 278–284. https://doi.org/10.1111/idj.12123 PMID: 25251783
35. Gauba A, Bal IS, Jain A, Mittal HC. School based oral health promotional intervention: Effect on knowledge, practices and clinical oral health related parameters. Contemp Clin Dent. 2013; 4(4): 493–499. https://doi.org/10.4103/0976-237X.123056 PMID: 24403795
36. Reinhardt CH, Lökper N, Noack MJ, Klein K, Rosen E. Peer tutoring pilot program for the improvement of oral health behavior in underprivileged and immigrant children. Pediatr Dent. 2009; 31(7): 481–485. PMID: 20108738
37. Tai B, Du M, Peng B, Fan M, Bian Z. Experiences from a school-based oral health promotion programme in Wuhan City, PR China. Int J Paediatr Dent. 2001; 11(4): 286–291. PMID: 11570445
38. Friel S, Hope A, Kelleher C, Comer S, Sadlier D. Impact evaluation of an oral health intervention amongst primary school children in Ireland. Health Promot Int. 2002; 17(2): 119–126. PMID: 11986293
39. Kaplis N, Drolette M, Boffa J, Kress G. A longitudinal study of multiple approaches to dental health education. Community Dent Oral Epidemiol. 1979; 7(3): 133–141. PMID: 287582
40. Anaise JZ, Zilkah E. Effectiveness of a dental education program on oral cleanliness of schoolchildren in Israel. Community Dent Oral Epidemiol. 1976; 4(5): 186–189. PMID: 1067152
41. Hart EJ, Behr MT. The effects of educational intervention & parental support on dental health. J Sch Health. 1980; 50(10): 572–576. PMID: 6904704
42. Rise J, Sögaard AJ. Effect of a mass media periodontal campaign upon preventive knowledge and behaviour in Norway. Community Dent Oral Epidemiol. 1988; 16(1): 1–4. PMID: 3422609
43. Mårtensson C, Söderfeldt B, Andersson P, Halling A, Renvest S. Factors behind change in knowledge after a mass media campaign targeting periodontitis. Int J Dent Hyg. 2006; 4(1): 8–14. https://doi.org/10.1111/j.1601-5037.2006.00158.x PMID: 16451434
44. Angelopoulou MV, Kavvadia K, Taoufik K, Oulis CJ. Comparative clinical study testing the effectiveness of school based oral health education using experiential learning or traditional lecturing in 10 year-old children. BMC Oral Health. 2015; 15: 51. https://doi.org/10.1186/s12903-015-0036-4 PMID: 25924670
45. Koch DM, Koch GM, Tynelius GM. Comparison of three methods of teaching oral hygiene to schoolchildren. J Dent Educ. 1970; 34(1): 98–104. PMID: 4190536
46. Haleem A, Siddiqui MI, Khan AA. School-based strategies for oral health education of adolescents-A cluster randomized controlled trial. BMC Oral Health. 2012; 12: 54. https://doi.org/10.1186/1472-6831-12-54 PMID: 23249443
47. Petersen PE, Peng B, Tai B, Bian Z, Fan M. Effect of a school-based oral health education programme in Wuhan city, people republic of China. Int Dent J. 2004; 54(1): 33–41. PMID: 15005471
48. Frencken JE, Borsum-Andersson K, Makoni F, Moyana F, Mwashaenji S, Mulder J. Effectiveness of an oral health education programme in primary schools in Zimbabwe after 3.5 years. Community Dent Oral Epidemiol. 2001; 29(4): 253–259. PMID: 11515638
49. Flanders RA. Effectiveness of dental health educational programs in schools. J Am Dent Assoc. 1987; 114(2): 239–242. PMID: 3469272
50. Young T, Rohwer A, Volmink J, Clarke M. What are the effects of teaching evidence-based health care (EBHC)? Overview of systematic reviews. PLoS One. 2014; 9(1): e86706. https://doi.org/10.1371/journal.pone.0086706 PMID: 24489771
51. Isman R. Public views on fluoridation and other preventive dental practices. Community Dent Oral Epidemiol. 1983; 11(4): 217–223. PMID: 6576880
52. National Center for Health Statistics. Health United States, 2015: With Special Feature on Racial and Ethnic Health Disparities. Hyattsville; 2016. pp. 270–271.
53. Slade G, Sanders A. Trends in oral health 1987–2006. In: Slade GD, Spencer AJ, Roberts-Thomson KF, editors. Australia’s dental generations: the National Survey of Adult Oral Health 2004–06. Canberra: Australian Institute of Health and Welfare; 2007. pp. 213–220
54. Morris J, Chenery V, Douglas G, Treasure E. Service considerations. In: O’Sullivan I, editor. Adult Dental Health Survey 2009. UK: The health and social care information centre; 2011. Available: http://content.digital.nhs.uk/pubs/dentalsurveyfullreport09
55. Ando Y, Ishida T, Fukai K, Ohyama A. The Status of Routine Dental Visits by Web-based Survey in Japan. J Dent Hyth. 2012; 62(1): 41–52 (in Japanese).
56. Khan K, Ruby B, Goldblatt RS, Schensul JJ, Reisine S. A pilot study to assess oral health literacy by comparing a word recognition and comprehension tool. BMC Oral Health. 2014; 14: 135. https://doi.org/10.1186/1472-6831-14-135 PMID: 25406963