Effects of self-efficacy on oral health behaviors and gingival health in university students aged 18- or 19-year-old

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Running title: Self-efficacy and gingival health

Abstract

Aim: Although self-efficacy is known to affect various health-related practices, few studies have clearly examined how self-efficacy correlates with oral health behaviors or the oral health condition. We examined the relationship between gingivitis, oral health behaviors and self-efficacy in university students.

Material and Methods: A total of 2,111 students (1,197 males, 914 females) aged 18 and 19 years were examined. The degree of gingivitis was expressed as the percentage of bleeding on probing (%BOP). Additional information was collected via a questionnaire regarding oral health behaviors (daily frequency of tooth-brushing, use of dental floss and regular check-up). Self-efficacy was assessed using the Self-Efficacy Scale for Self-care. Path analysis was used to test pathways from self-efficacy to oral health behaviors and %BOP.

Results: In the final structural model, self-efficacies were related to each other, and they affected oral health behaviors. Good oral health behaviors reduced dental plaque and calculus, and lower levels of dental plaque and calculus resulted in lower %BOP.

Conclusion: Higher self-efficacy correlated with better oral health behaviors and gingival health in university students. Improving self-efficacy may be beneficial for maintaining good gingival health in university students. To prevent gingivitis, the approach of enhancing self-efficacy in university students would be useful.

Clinical Relevance:

Scientific rationale for the study: Although the correlation between self-efficacy and oral health behaviors or adherence to periodontal treatment has been reported, the associations between self-efficacy, oral health behaviors and gingivitis is not known.

Principal findings: Higher self-efficacy in university students correlates with better oral health behaviors and lower levels of %BOP, and the associations between three components were proved by path analysis. The concept of self-efficacy is useful for an epidemiological survey in periodontology.

Practical implications: The results may contribute to the strategy of enhancing his/her self-efficacy in general population of young people.

Introduction

Self-efficacy is advocated within the framework of social learning theory and is defined as an individual’s confidence in determining ‘how well he or she can take the actions necessary for producing certain results’ (Bandura 1977). There are two levels of self-efficacy (Sherer et al. 1982, Stanley & Murphy 1997): general self-efficacy, which is reflected in an individual’s general tendency, and task-specific self-efficacy, which is an individual’s efficacy in relation to a certain task. Indeed, medical clinical practice has focused on the function of self-efficacy as an antecedent factor for behavior modification, and symptoms of even diabetes and other chronic diseases can be improved by enhancing self-efficacy (Smarr et al. 1997, Wattana et al. 2007). Self-efficacy is also related to various health-related practices, such as smoking cessation, diet and a health-promoting lifestyle (Nicki et al. 1984, Pender et al. 1990, Robinson & Thomas 2004).

In the field of dentistry, correlations have been reported between self-efficacy and frequencies of brushing, flossing and dental visits (Stewart et al. 1997). A cognitive behavioral intervention group significantly increases brushing and flossing frequency and significantly reduces the plaque index compared with a control group (Tedesco et al. 1992). In addition, cognitive behavioral intervention improves the self-efficacy of flossing (Stewart et al. 1991). Higher self-efficacy in periodontal patients correlates with better adherence to oral hygiene instruction and periodontal treatment (Kakudate et al. 2008, 2010). Whether or not people with periodontal disease can properly adhere to these health regimens is the key to success in preventing periodontal diseases. Therefore, people with relatively greater self-efficacy may exhibit overall better self-care behaviors and periodontal health than those with relatively lower self-efficacy. Few studies have, however, attempted to scientifically examine the associations between self-efficacy, oral health behaviors and periodontal health. In addition, the usefulness and validity of self-efficacy for the treatment of periodontal disease has been proved in clinical research, but not in an epidemiological study dealing with the actual population.

For preventing gingivitis, it is important to focus on young people. Epidemiological studies have shown that gingivitis is prevalent in more than 82% of U.S. adolescents (Albandar & Rams 2002) and more than 70% of the Japanese youth (The Statistical Analysis Committee on the Survey of Dental Diseases, 2005). Although gingivitis does not always progress to periodontitis, periodontitis is always preceded by gingivitis. Understanding how self-efficacy affects oral health behaviors and the gingival condition in young people may enable efficient prevention of periodontitis through improved therapeutic approaches against gingivitis in young people.

We hypothesized that self-efficacy influences oral health behaviors and gingivitis in university students through the following process: (i) gingivitis is caused by the accumulation of dental plaque and calculus, (ii) this accumulation is a direct result of poor oral health behaviors (i.e. infrequent tooth-brushing, no use of dental floss and infrequent dental attendance patterns), and (iii) poor oral health behaviors are directly affected by lower scores of self-efficacy. Although clinicians empirically believe this process, investigating whether the process makes sense is required because few studies have attempted to examine the associations.

The aim of the present study was to explain the associations between gingivitis, oral health behaviors and self-efficacy in university students, utilizing path analysis (Furuta et al. 2010, Kile et al. 2011).

Materials and Methods

Study population

Of 2,395 first-year students who underwent a general health examination at the Health Service Center of Okayama University in April 2011, 2,319 students volunteered to receive an oral examination and answered the questionnaire described below. We excluded 208 subjects who were ≥20 years old (n=117), were current smokers (n=4), and had provided incomplete data in their questionnaires (n=87). As a result, data from 2,111 students (1,197 male, 914 female) aged 18 and 19 years were analyzed. The higher majority of men was generally in line with the gender distribution of the respective population in Okayama and also partly influenced by the composition of Okayama University, whereby there was a large Engineering Department with predominantly male students. The study was approved by the Ethics Committee of Okayama University Graduate School of Medicine, Dentistry and Pharmaceutical Sciences. Verbal consent was obtained from all subjects.

Questionnaire

We distributed a questionnaire, which was mailed before the health examination. Besides sex, age, general condition and smoking status, the questionnaire included the following items:

Oral health behaviors: Subjects were asked their daily frequency of tooth brushing and use of dental floss (Furuta et al. 2010).

Regular check-up: Subjects were asked if they had visited a dental clinic for a regular check-up during the past year (Furuta et al. 2010).

Self-Efficacy Scale for Self-care (SESS) (Kakudate et al. 2008): Recently, Self-Efficacy Scale for Self-care (SESS) was developed for use with periodontal disease patients. Thus, the SESS was used in this study. Briefly, the scale consists of 15 items divided into three subscales: SE-DC, which is evaluation of self-efficacy for continuing treatment and regular dental check-up (for example, “I go to the dentist for treatment of periodontal disease”); SE-BR, which evaluates self-efficacy for brushing one’s own teeth carefully and thoroughly (for example, “I brush my teeth as instructed”), and SE-DH, which evaluates self-efficacy for adopting well-balanced eating and drinking habits (for example, “I eat my meals at fixed times during the day”). Preliminary, the internal consistency and test-retest stability of SESS were investigated using Okayama University students (n=42). The SESS showed sufficient internal consistency (Cronbach’s α=0.85). The intra-class correlation coefficient (ICC) was calculated from assessments between two tests and it was 0.972 (95% confidence interval: 0.967-0.976). Furthermore, %BOP in subjects who had higher self-efficacy was significantly lower than that in subjects who had lower one [19.1 ± 15.1 (mean ± SD) vs. 58.2 ± 11.3, p<0.05]. The effect size was also assessed using Cohen's d (t-test) and the value was 2.9, which was high effect size (Cohen 1988). These results suggest that the SESS has a good reliability and validity, and will endure epidemiological survey. In this study, if a student answered “completely confident” or “generally confident” for the question in SESS, the answer was considered as “high” self-efficacy. On the other hand, “moderately confident”, “poorly confident” or “not confident” were assigned to “low” self-efficacy. Thus, the number of high self-efficacy was calculated for each subscale.

Oral Examination

Four dentists (S.M., D.E., K.I., and T.A.) examined the oral health status of the study subjects. The number of teeth in the mouth was counted. Periodontal condition was assessed using the Community Periodontal Index (CPI) (Furuta et al. 2010). Ten teeth were selected for periodontal examination: two molars in each posterior sextant and the upper right and lower left central incisors. Measurements were made using a CPI probe (YDM, Tokyo, Japan) at six sites (mesio-buccal, mid-buccal, disto-buccal, disto-lingual, mid-lingual and mesio-lingual) per tooth. The percentage of teeth exhibiting bleeding on probing (%BOP) was calculated. BOP is an earlier and more sensitive indicator of inflammation than probing pocket depth or visual signs of inflammation (redness and swelling) (Greenstein 1984). Thus, we assessed %BOP as an indicator of periodontal disease or gingivitis in this study (Furuta et al. 2011). The level of dental plaque and calculus was assessed using the oral hygiene index (Greene et al. 1964). Intra- and inter-examiner agreement for the oral examination was good, as evaluated by kappa statistics of more than 0.8.

Statistical Analyses

The χ^2 test and *t* test were used to compare the sex differences. A p<0.05 was considered to be significantly differences. A statistical program (SPSS version 17.0; IBM, Tokyo, Japan) was used for data analyses.

Path analysis was used to examine the proposed relationships between self-efficacy, oral health behaviors and the oral condition. Relationships between the constructs were assessed using Mplus version 6 (Muthén & Muthén, Los Angeles, CA, USA). Our data included continuous variables and several dichotomous variables and those with three categories. Therefore, the path analysis was performed using weighted least-squares parameter estimates (WLSMV). WLSMV uses a diagonal weight matrix with robust standard errors and mean- and variance- adjusted chi-square test statistics. For the global fit indices, a non-significant chi-square indicates that the data does not significantly differ from the hypotheses represented by the model; for comparative fit index (CFI) and Tucker-Lewis index (TLI), fit indices of above 0.90 (preferably above 0.95) are the criteria utilized to indicate a well-fitting model (Hu & Bentler 1999). For root mean square error of approximation (RMSEA), a fit of less than 0.05 indicates a well-fitting model (Browne & Cudeck 1993). Finally, requiring parsimony leads to the retention of a model with the fewest parameters that still meet the other criteria.

The effect size was also assessed using correlation coefficient or standardized coefficient corresponded to *r* (Cohen 1988). Effect size is an indicator of the meaningfulness of a change in a health status measure. The small, medium and large effect sizes are 0.10, 0.30 and 0.50 (Cohen 1988).

Results

Table 1 shows the results of oral condition and the questionnaire about oral health behaviors. The percentage of subjects who brush their teeth twice daily was 71.5%, with “3 times or more” being the fewest (9.8%). The percentages of subjects who use dental floss and who visit a dental clinic for regular check-up were 4.8% and 14.2%, respectively. Females had significantly lower levels of dental plaque and calculus than males (p<0.001). The frequency of tooth brushing and percentages of subjects who use dental floss and who visit a dental clinic for regular check-up in females was significantly higher than those in males (p<0.001). The percentage of subjects with CPI code 3 and 4 were 10.9% and 0.14%, respectively. There was no significant difference in %BOP and CPI between males and females.

The results of self-efficacy score are presented in Table 2. Female had significantly higher score in SE-DC (p<0.05), but there were no significant difference between male and female in SE-BR and SE-DH.

We estimated a final model with all hypothesized pathways. The value of chi-square was significant because of our large sample size (χ^2 =53.614, df =22, and p<0.01). CFI, TLI and RMSEA values indicated good model-data fit (0.984, 0.973 and 0.026, respectively). Figure 1 shows the parameters estimated for the final structural model. The model showed that (i) SEs correlated with each other and these effect sizes were almost moderate; (ii) SE-BR affected the use of floss and brushing times with small to moderate effect sizes; (iii) SE-DC affected regular dental check-up with small effect size; (iv) good oral health behaviors reduced dental plaque with small to moderate effect sizes; and (v) lower levels of dental plaque and calculus were associated with lower %BOP, and these effect sizes were large and medium, respectively. All pathways were significant (p<0.01) (Table 3).

Discussion

Self-efficacy, which is a remarkable antecedent factor for behavior modification, is related to various health-related practices, including adherence to oral hygiene instruction (Kakudate et al. 2008). However, few studies have attempted to examine the associations between self-efficacy, oral health behaviors and gingival health. Moreover, the usefulness and validity of self-efficacy has not been proved in an epidemiological study dealing with general population. To the best of our knowledge, this is the first study to scientifically assess and confirm the associations/process between the three components. Understanding self-efficacy has proven to be useful for epidemiological surveys in periodontology. Our results showed that the students with high self-efficacy had higher levels of oral health behaviors and lower levels of %BOP than those with low self-efficacy.

The results of this study revealed the positive influence of self-efficacy on gingivitis by showing that: (i) students with high self-efficacy have a more positive attitude to regular dental visits than those with low self-efficacy, (ii) self-efficacy has direct and indirect effects on oral health behaviors, and (iii) students with low levels of dental plaque and calculus have lower %BOP than those with poor oral hygiene status (high levels of dental plaque and calculus), because oral hygiene status is influenced by oral health behaviors.

The effect sizes in the three pathways; SE-BR to floss, SE-BR to tooth-brushing and SE-DC to regular check-up were small. On the other hands, the effect sizes in the two pathways; regular check-up to floss and floss to dental plaque were medium. Lower level of dental plaque was associated with lower %BOP and the effect sizes were large. These results suggest that high self-efficacy might have relatively weak contribution to good oral hygiene, whereas good oral hygiene greatly relates to lower %BOP.

The effects of self efficacy on oral health behaviors were also confirmed in a previous report, which examined the correlation between self-efficacy and frequencies of brushing, flossing and dental visits (Stewart et al. 1997). It was previously shown that it is possible to increase the self-efficacy of flossing by cognitive behavioral intervention (Stewart et al. 1991). Therefore, enhancing young people’s self-efficacy might contribute to their good oral health behaviors (increasing brushing and flossing frequency), improve oral hygiene status and help maintain gingival health.

In previous studies (Kakudate et al. 2008, 2010), periodontitis patients with lower self-efficacy scores were more likely to discontinue follow-up for long-term periodontal supportive therapy as well as short-term active treatment. These findings suggest that self-efficacy scores are useful for predicting periodontal health in patients who start periodontal treatment. In this study as well, higher self-efficacy in university students correlated with better gingival health. Therefore, evaluation of self-efficacy might be required in university students for the prevention of gingivitis so that for people with lower self-efficacy, attempts can be made to improve their self-efficacy. In Japan, health examination is required to be performed on a regular basis, according to a school health law. Since control of the risk factors of periodontal disease at an early stage is essential in its prevention in younger populations, monitoring of self-efficacy scores on regular health examinations might be useful.

Many studies have analyzed the relationship between periodontal diseases and oral health behaviors or between self-efficacy and failure of follow-up with long-term periodontal treatment, putting specific variables into mathematically determined models (Horning et al. 1992, Karikoski et al. 2001, Susin et al. 2005, Kakudate et al. 2010). In multivariate analyses, many researchers prefer to use the logistic regression or multiple linear regression analysis, which is based on only one dependent variable and cannot reveal complex and diverse relationships between independent and dependent variables. Path analysis, on the other hand, enables variables to act both independently and dependently, and can explore the complex causal relationship involved in disease processes (Furuta et al. 2010). Therefore, we used path analysis to explore the complex causal relationships between gingivitis, oral health behaviors and self-efficacy in this study.

Our study has some limitations. We did not consider possible related factors, such as socioeconomic status (Morita et al. 2007, Cronin et al. 2008), psychosocial factors (Genco et al. 1999) and social capital (Furuta et al. 2011), in this study. Several studies reported a relationship between socioeconomic status and periodontal disease (Morita et al. 2007, Cronin et al. 2008). Future studies are needed to reveal these effects. Second, since this study was cross-sectional, it is therefore still uncertain as to whether high SESS is the cause of good oral behaviors and gingival health. Prospective cohort studies may provide information beyond what we present here. Third, we examined only 10 teeth in the oral examination. It might be difficult to treat %BOP as continuous scale. Finally, all subjects were recruited from among students at Okayama University, which may limit the ability to extrapolate these findings to the general population of young people.

In conclusion, this study revealed that higher self-efficacy in university students correlates with better oral health behaviors and gingival health. Enhancing self-efficacy may be a useful approach to prevent gingivitis in university students.

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Figure legends

Figure 1. The final structural model. Self-efficacy: SE-BR, SE-DH, SE-DC. Oral health behaviors: Flossing, tooth-brushing, regular check-up. Oral health condition: Dental plaque, calculus, %BOP. The values of double-headed arrows indicate correlation coefficient and those of single-headed arrows indicate standardized coefficient. All pathways are significant (*p*<0.01). Higher levels of self-efficacy result in better oral health behaviors, and better oral health behaviors lead to lower levels of dental plaques, calculus and %BOP.

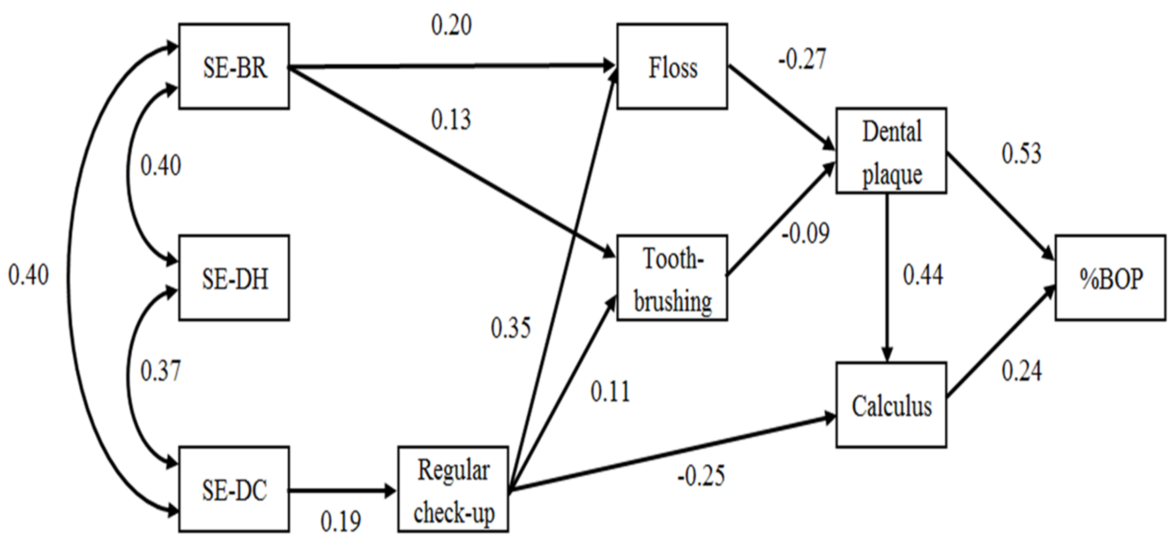

Table 1. Oral health condition and health behaviors

Oral health condition	Males (n=1,197)	Females (n=914)	Total (n=2,111)
Community Periodontal Index			
code 0	177 (14.8)*	134 (14.7)	311 (14.7)
code 1	227 (19.0)	182 (19.9)	409 (19.4)
code 2	677 (56.6)	481 (52.6)	1,158 (54.9)
code 3	114 (9.5)	116 (12.7)	230 (10.9)
code 4	2 (0.2)	1 (0.1)	3 (0.1)
%BOP	29.94 ± 26.35**	28.24 ± 26.18	29.20 ± 26.28
Dental plaque (Debris Index-Simplified)†	0.52 ± 0.39	0.43 ± 0.35	0.48 ± 0.38
Calculus (Calculus Index-Simplified)†	0.18 ± 0.24	0.15 ± 0.21	0.17 ± 0.23
Health behaviors			
Tooth brushing (daily frequency) ††			
1 time	310 (25.9)	84 (9.2)	394 (18.7)
2 times	810 (67.7)	700 (76.6)	1,510 (71.5)
≥3 times	77 (6.4)	130 (14.2)	207 (9.8)
Dental floss ††			
Used	40 (3.3)	61 (6.7)	101 (4.8)
Not used	1,157 (96.7)	853 (93.3)	2,010 (95.2)
Underwent dental examinations this year ††			
Yes	140 (11.7)	159 (17.4)	299 (14.2)
No	1,057 (88.3)	755 (82.6)	1,812 (85.8)

* Number (%)

** Mean ± SD

†Significant difference between males and females (*t* test; p <0.001).

††Significant difference between males and females (the χ^2 test; p <0.001).

Table 2. Distribution of Self-efficacy scale for self-care score

Number of answer assigned to high self-efficacy[*]	Males (n=1,197)	Females (n=914)	Total (n=2,111)
Self-efficacy for brushing of the teeth			
0	0 (0.0) [**]	0 (0.0)	0 (0.0)
1	313 (26.1)	220 (24.1)	533 (25.2)
2	203 (17.0)	148 (16.2)	351 (16.6)
3	377 (31.5)	296 (32.4)	673 (31.9)
4	90 (7.5)	65 (7.1)	155 (7.3)
5	214 (17.9)	185 (20.2)	399 (18.9)
Self-efficacy for dietary habits			
0	0 (0.0)	0 (0.0)	0 (0.0)
1	376 (31.4)	256 (28.0)	632 (29.9)
2	244 (20.4)	172 (18.8)	416 (19.7)
3	217 (18.1)	205 (22.4)	422 (20.0)
4	152 (12.7)	111 (12.1)	263 (12.5)
5	208 (17.4)	170 (18.6)	378 (17.9)
Self-efficacy for dentist consultation[†]			
0	0 (0.0)	0 (0.0)	0 (0.0)
1	305 (25.5)	185 (20.2)	490 (23.2)
2	211 (17.6)	151 (16.5)	362 (17.1)
3	295 (24.6)	236 (25.8)	531 (25.2)
4	196 (16.4)	157 (17.2)	353 (16.7)
5	190 (15.9)	185 (20.2)	375 (17.8)

[*]Answer, “completely confident” or “generally confident” for each question was considered as high self-efficacy.

[**]Number (%)

[†]Significant difference between males and females (the χ^2 test; p <0.05).

Table 3. Correlation coefficient and standardized coefficient between parameters

Parameter	Correlation coefficient	*p*-value
SE-BR and SE-DC	0.398	p <0.001
SE-BR and SE-DH	0.401	p <0.001
SE-DC and SE-DH	0.373	p <0.001
Parameter	**Standardized coefficient**	***p*-value**
Check-up ← SE-DC	0.191	p <0.001
Brushing ← SE-BR	0.125	p <0.001
Floss ← SE-BR	0.195	p <0.001
Brushing ← Check-up	0.114	0.003
Floss ← Check-up	0.348	p <0.001
DI-S ← Floss	-0.266	p <0.001
DI-S ← Brushing	-0.086	0.002
CI-S ← DI-S	0.441	p <0.001
CI-S ← Check-up	-0.252	p <0.001
%BOP ← CI-S	0.241	p <0.001
%BOP ← DI-S	0.529	p <0.001

SE-BR, self-efficacy for brushing of the teeth; SE-DH, self-efficacy for dietary habits; SE-DC, self-efficacy for dentist consultation; DI-S, Debris Index-Simplified; CI-S, Calculus Index-Simplified; %BOP, the percentage of teeth that bled on probing.