Determinants of self-assessed gingival health among adolescents

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The purpose of the present cross-sectional study was to assess the extent of agreement between clinical and self-assessed gingival health and to investigate possible factors associated with the amount of self-assessed gingival bleeding. A study group comprising students enrolled in grade 7 or 8 in Helsinki, Finland (n = 172), performed a self-assessment based on two tests: the amount of bleeding after toothbrushing and after interproximal tooth cleaning with toothpicks. Clinical examinations based on bleeding on probing (BOP%) were carried out by four local community dentists. The highest observed kappa value was 0.43 for the agreement between BOP% and self-assessment when tested with different cut-off points of diagnosis. Multivariate analysis showed that clinical status and toothbrushing frequency were statistically significantly associated with self-assessed gingival bleeding in both tests. Socioeconomic status and locus of control orientation were also statistically significant factors in the toothpick test. In conclusion, the validity of self-assessment of bleeding was sufficient for monitoring adolescents' gingival health in groups. Self-assessed bleeding was explained by the same factors that were associated with clinical gingival health status.
☐ *Dental public health; diagnosis; monitoring; self-care*

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Self-assessment of gingival health refers to an educational method to improve gingival health status. Individuals are asked to carry out clinical measurement procedures, such as assessing the amount of plaque by means of disclosing wafers or counting the number of bleeding sextants after toothbrushing or interproximal cleaning with toothpicks. The results of the self-assessment are recorded on a chart, and written or verbal information is provided as to how to interpret the results of self-assessment (1).

The periodic collection of oral disease data is a fundamental aspect of dental public health practice at the state and local levels (2). The gathering of such data is considered an integral part of the planning, monitoring, and evaluation functions of state- and local-level dental agencies (2, 3). The cost of conducting oral health surveys is a barrier to developing oral health programs in industrialized and third-world countries, and low-cost alternatives have been developed and proposed (3, 4). Self-assessment has been suggested as an alternative method of monitoring the gingival health of adolescent populations (5).

Søgaard & Holst (6) reviewed oral health behavior studies in Scandinavian adolescents and found five factors that are positively associated with toothbrushing frequency: age, status of householder's occupation, educational level of the fathers, success at school, and degree or urbanization. Reisine & Bailit (7) suggested that age, gender, and social class may be crucial intervening variables in determining how individuals perceive and evaluate oral health status. Addy et al. (8) reported that social class and sex were more strongly associated with oral hygiene and gingival health than toothbrushing among British adolescents.

The aims of this study were, first, to assess the level of agreement between clinically diagnosed and self-assessed gingival health at different diagnostic cut-off points and, secondly, to test factors that could be associated with self-assessed bleeding in the toothbrush and toothpick tests in an adolescent study population in Helsinki.

Materials and methods

Study population

The study population consisted of 193 students (age, 14.0 ± 0.7 years) enrolled in grade 7 or 8 in 3 schools in Helsinki. The students had been selected for an oral self-care program because of their below-average clinical gingival health status. The motivational effect of the program was based on the self-assessment of gingival bleeding after both toothbrushing and interproximal cleaning of teeth with toothpicks (9, 10). Of the 193 selected students, 172 (89%) completed the longitudinal self-care program, returned their self-assessment forms and questionnaires, and attended all three clinical examinations. The reasons for exclusion were incomplete data, failure to attend clinical examinations, and moving out of the area during the study. Two per cent refused to participate in the self-assessment program. Description of the sample and selection of the students have been reported in detail elsewhere (5). Complete questionnaire data for multivariate analyses were available from 152 subjects.

Table 1. Classification of the background variables

Independent variables	Category	Value
Gender	Girls	0
	Boys	1
Locus of control orientation (I): 'Do you believe that flossing can reduce caries?'	Internal, agree	0
	External, disagree	1
Locus of control orientation (II): 'Are some dentists better than others?'	Internal, agree	0
	External, disagree	1
Use of toothfloss in the past 12 months	Frequently or sometimes	0
	No or do not know	1
Use of toothpicks in the past 12 months	Frequently or sometimes	0
	No or do not know	1

Clinical examinations

Clinical examinations coincided with the traditional annual check-ups and were carried out by four dentists at municipal dental clinics. The clinical examination was based on probing six sites on all teeth (distobuccal, buccal, mesiobuccal, mesiolingual, lingual, and distolingual) except the third molars. An individual bleeding on probing (BOP) index of the dichotomous scores was calculated in accordance with Ainamo & Bay (11). Interproximal sites were scored from both buccal and lingual sides of the contact area. Either side could contribute to a positive score for the interproximal region. The maximum number of potential bleeding units was thus 28 × 4 units (mesial, buccal, lingual, and distal surfaces). The BOP value was calculated as the percentage of bleeding units of the total number of sites examined per individual (BOP%). WHO ball-pointed periodontal probes were used in clinical examinations. The examiners participated in a 1-day training session, during which they were instructed by one of the authors (P. Kallio) in the recording system and the use of 20 g probing pressure. The interexaminer variation was assessed and is reported elsewhere (1).

Self-assessment tests

The self-assessment of bleeding involved identifying the presence or absence of bleeding, first after toothbrushing (a toothbrush test) and second after interproximal cleaning with toothpick (a toothpick test) and was performed on average 4.2 months after clinical examination (5). The results were recorded on a dental chart divided into sextants. The maximum self-assessed bleeding score was 12 (6 bleeding sextants from both tests). Clinical gingival health measurement based on the use of toothpicks by dental personnel has been reported and evaluated earlier (12–14). All subjects received standard soft-bristled toothbrushes, wedge-shaped toothpicks, mouth mirrors, and self-instructional leaflets that included written and illustrated instructions on how to carry out self-assessment tests without inducing trauma. The leaflets also included guidelines on the interpretation of the test findings for the purpose of maintaining good oral hygiene. The students performed their self-assessments independently and without supervision but at the health centers.

Questionnaire

The students filled out the pre-tested self-completed questionnaire in the waiting room before the clinical examinations. The examining dentists did not check the answers or discuss responses. The respondent's school performance was determined as the average of grades in the last school report. Locus of control orientation (15) was assessed with two items (Table 1). Oral self-care items included questions about toothbrushing frequency and use of floss and toothpicks.

An area-based socioeconomic profile was calculated for each school in the study, on the basis of the proportion of blue-collar workers among the parents

Table 2. Kappa agreement between dichotomized dentist's assessment and self-assessed bleeding at different cut-off points. Prevalences (base rates) in parentheses (n = 172)

No. of bleeding self-assessed sextants in toothbrush and toothpick tests	BOP%*				
	≤20 (28%)	≤40 (56%)	≤50 (69%)	≤60 (77%)	≤80 (95%)
≥10 (5%)	κ = 0.04	κ = 0.09	κ = 0.13	κ = 0.10	κ = −0.01
≥7 (8%)	κ = 0.15	κ = 0.27	κ = 0.33	κ = 0.34	κ = 0.08
≥4 (41%)	κ = 0.34	$\underline{\kappa = 0.43}$	κ = 0.41	κ = 0.32	κ = 0.09
≥1 (84%)	κ = 0.28	$\overline{\kappa = 0.20}$	κ = 0.14	κ = 0.08	κ = 0.02

* BOP% = percentage of bleeding units of the total number of sites examined per individual.

Table 3. The stability of the studied variables over a period of 1 year

	Kappa
BOP%	0.46
Socioeconomic background	NA
Age	NA
Gender	NA
School record	0.74
Toothbrushing frequency	0.74
Use of toothfloss	0.45
Use of toothpicks	0.10
External locus of control, item I	0.26
External locus of control, item II	0.39

BOP% = percentage of bleeding units of the total number of sites examined per individual; NA = not applicable.

(16). Average area incomes were highly correlated with the proportion of blue-collar workers ($r = -0.96$).

Statistical analysis

Multiple linear regression analysis was used to investigate the effects of the independent variables on clinical gingival health change over time (17). Independent variables, including gender and questionnaire data, were categorized for the multivariate analysis as shown in Table 1. BOP%, socioeconomic background (that is, the proportion of blue-collar workers among the parents in the study schools), age, school record, and toothbrushing frequency were included in the multivariate analysis as continuous variables. For the assessment of the agreement between self-assessment and clinical assessments percentage agreement, Cohen's kappa, and sensitivity/specificity analyses were applied. The scale suggested for positive kappa values by Landis & Koch (18) was used as the reference of agreement: 0 = poor, 0–0.20 = slight, 0.21–0.40 = fair, 0.41–0.60 = moderate, 0.61–0.80 = substantial, and 0.81–1.00 = almost perfect.

Results

The highest agreement between the dentist's assessment (BOP%) and self-assessed bleeding was found when BOP% was ≤40% and the cut-off point for the self-assessed bleeding was a total of at least four bleeding sextants in the toothbrush and toothpick tests. Kappa agreement was 0.43 (Table 2). At this level, sensitivity was 64%, specificity 78%, and percentage agreement 72%.

The studied variables showed high stability over a period of 1 year for self-reported school performance and toothbrushing frequency, whereas the data for the self-reported use of toothpicks indicated instability in the responses. The kappa agreement between two BOP% examinations 1 year apart was $\kappa = 0.46$ (Table 3).

The multivariate analyses showed that clinical status, BOP%, was the most significant factor associated with the number of bleeding sextants in the toothbrush and toothpick tests ($P < 0.001$) (Table 4). In addition, toothbrushing frequency was negatively associated with the amount of self-assessed bleeding in both tests. Blue-collar socioeconomic background and external locus of control were positively associated with the number of self-assessed bleeding sextants, but only in the toothpick test.

Discussion

In the present analysis a moderate (kappa = 0.43) agreement between self-assessment and clinical examination was achieved. This agreement was most likely affected by the fact that on average 4.2 months had elapsed between the different measurements. It has been shown that gingivitis may develop within 2 weeks in the absence of plaque control (19). It has also been reported that plaque accumulates much faster on

Table 4. Regression coefficients for number of self-assessed bleeding sextants among adolescents after the toothbrushing test (A) and after the toothpick test (B) ($n = 152$)

	Regression coefficient		Student's *t* statistic		*P*<	
	A	B	A	B	A	B
Intercept	3.70	3.70				
BOP%	0.03	0.35	5.06	4.89	0.0001	0.0001
Blue-collar socioeconomic background	0.02	0.11	0.63	2.64	NS	0.01
Age	−0.17	−0.19	1.04	1.05	NS	NS
Male gender	0.22	−0.25	0.91	0.94	NS	NS
School record	−0.14	−0.16	1.12	1.15	NS	NS
Toothbrushing frequency	−0.38	−0.32	2.87	2.20	0.01	0.05
Use of toothfloss	−0.12	−0.18	0.38	0.52	NS	NS
Use of toothpicks	−0.29	0.13	1.17	0.49	NS	NS
External locus of control, item I	−0.07	0.62	0.27	1.99	NS	0.05
External locus of control, item II	0.09	−0.01	0.32	0.03	NS	NS

$R^2 = 0.25$ (A), 0.33 (B).
BOP% = percentage of bleeding units of the total number of sites examined per individual.

erupting teeth than on fully erupted teeth (20) and next to inflamed sites (21). This may account for the negative effect on the level of agreement in this study population with erupting second molars. Because of the feasibility and desirability of selecting the study group and of launching the self-assessment program within the framework of the community dental service, the length of time between different measurements was inevitable. Another factor that could have further decreased the agreement between two measurements was the interexaminer variability among four dentists from the municipal dental service. As interexaminer variability is unavoidable in daily practice, the results accord with real-life circumstances in this respect. It is assumed that higher than moderate agreement is possible, but this may not be necessary, as the potential diagnostic application of the self-assessment of bleeding is the monitoring of gingival health in groups. The other known and at least equally important application of self-assessment is to motivate patients to improve their own oral hygiene habits (9, 10, 22, 23). The observed higher specificity than sensitivity for self-assessed bleeding suggests that some students were not aware of the presence of their gingival inflammation. This could possibly be improved by giving more thorough instructions to the participants. A general neglect among adolescents in carrying out self-assessment tests could jeopardize the successful use of the method, which calls for successful cooperation with the dental personnel. In our study only 2% of the 193 selected students refused to participate, and overall loss of the subjects over the 1-year period was only 11%, indicating good compliance among adolescents and commitment on the part of the dental personnel.

Important factors associated with the amount of self-assessed gingival bleeding were BOP% and toothbrushing frequency, which are logical factors and thus support the validity of the self-assessment of bleeding. Blue-collar socioeconomic background was also significantly associated in the outcome of the toothpick test, which accords with the earlier findings on determinants for gingival health (6–8). The fact that the socioeconomic factor was significant only in the toothpick test could be explained by the earlier findings that the toothpick test is more valid and more sensitive that the toothbrush test (5). The stronger association of social class than of toothbrushing in the toothpick test accords with a previous finding by Addy et al. (8). In our study socioeconomic data were provided by an area-based measure. Locker & Ford (24, 25) have evaluated an area-based measure as an indicator of inequalities in oral health among a sample of elderly Canadians. The area-based measure was found to be only marginally weaker than household income but was more useful owing to a better response rate (24). Our finding suggests that area-based socioeconomic measures may also be useful in adolescent populations. In the present study gender was not significantly associated with self-assessed bleeding because we were subsampling a population with more gingivitis than average. The negative association with gender, however, excludes the possibility that gender would affect how adolescents perceive their findings.

The positive association of the external locus of control orientation with self-assessed bleeding should be cautiously interpreted, as this finding was based on only one of two items. Theoretically, this association is correct, as external orientation is supposed to hinder good oral self-care behavior (15).

Our results showed that self-assessment of bleeding could be a valid method to monitor gingival health in Finnish adolescent populations. For economic reasons the traditional annual check-up frequency among schoolchildren has been reduced in Finland. Self-assessment of gingival health could supplement other means of providing data for monitoring gingival health and for motivating schoolchildren to better self-care.

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