

Prevalence of Halitosis in Young Male Adults: A Study in Swiss Army Recruits Comparing Self-Reported and Clinical Data

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Background: Sound epidemiologic data on halitosis are rare. We evaluated the prevalence of halitosis in a young male adult population in Switzerland using a standardized questionnaire and clinical examination.

Methods: Six hundred twenty-six Swiss Army recruits aged 18 to 25 years (mean: 20.3 years) were selected as study subjects. First, a standardized questionnaire focusing on dental hygiene, self-reported halitosis, smoking, and alcohol consumption was filled out by all participants. In the clinical examination, objective values for the presence of halitosis were gathered through an organoleptic assessment of the breath odor and the measurement of volatile sulfur compounds (VSCs). Additionally, tongue coating, plaque index, and probing depths were evaluated for each recruit.

Results: The questionnaire revealed that only 17% of all included recruits had never experienced halitosis. The organoleptic evaluation (grades 0 to 3) identified eight persons with grade 3, 148 persons with grade 2, and 424 persons with grade 1 or 0. The calculation of the Pearson correlation coefficient to evaluate the relationship among the three methods of assessing halitosis revealed little to no correlation. The organoleptic score showed high reproducibility ($\kappa = 0.79$). Tongue coating was the only influencing factor found to contribute to higher organoleptic scores and higher VSC values.

Conclusions: Oral malodor seemed to pose an oral health problem for about one-fifth of 20-year-old Swiss males questioned. No correlation between self-reported halitosis and organoleptic or VSC measurements could be detected. Although the organoleptic method described here offers a high reproducibility, the lack of correlation between VSC values and organoleptic scores has to be critically addressed. For further studies assessing new organoleptic scores, a validated index should always be included as a direct control. *J Periodontol* 2009;80:24-31.

KEY WORDS

Epidemiology; halitosis; oral hygiene; smoking.

Halitosis is the term used to define an unpleasant or offensive odor in expired air, regardless of whether it originates from oral or non-oral sources. Other terms include bad or foul breath, breath odor, foul smells, foetor ex ore, breath malodor, oral malodor, and offensive breath. Halitosis can be caused by several intra- and extraoral factors. Oral sources mentioned in the literature are tongue coating, periodontal disease, extensive carious lesions with exposed tooth pulps, pericoronitis, mucosal ulcerations and diseases, impacted food and debris, unclean dentures, and a decreased salivary flow rate.¹ Although the oral cavity is the main source of bad breath in most individuals, the following pathologic conditions are also reported to cause halitosis: chronic sinusitis with postnasal drip, neglected foreign bodies in the nose (especially in children and mentally handicapped patients), bronchitis, pneumonia, esophageal reflux, pyloric stenosis, hiatal hernia, diabetic ketoacidosis, hepatic failure, kidney dialysis, and leukemia.²

There are only limited data available in the literature concerning the prevalence of halitosis in population-wide samples. Often, these studies³⁻⁵ use subjective criteria from questionnaires to estimate the percentage of affected people in a population. These data have to be considered with some caution, because it is known

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that subjective reports on oral malodor often cannot be correlated with objective findings.⁶⁻⁸ An epidemiologic study from Japan⁹ showed that between 6% and 23% of the population suffered from halitosis based on measurements of volatile sulfur compounds (VSCs). A similar study¹⁰ analyzing objective findings on halitosis from China reported a prevalence of 20% to 34%.

In general, there seems to be no gender-specific difference in the prevalence or severity of halitosis.^{7,8,11} However, women seem to be more willing to consult health care professionals about their problem.¹¹ In a study of 2,672 patients, aged 18 to 64 years, from Japan, Miyazaki et al.⁹ found that oral malodor might be caused mainly by tongue coating in the younger generation, whereas periodontal diseases together with tongue coating were more important factors in older cohorts. In Europe, epidemiologic data using self-reported and objective criteria on the prevalence of oral malodor are still rare. Limited data are available from Sweden¹² and from a multidisciplinary oral malodor clinic in Belgium.^{13,14}

The aim of the present study was to estimate the prevalence of halitosis in a population of young Swiss males using a questionnaire for self-reported findings and organoleptic and VSC measurements for objective clinical parameters. Anamnestic and clinical parameters influencing the severity of the detected halitosis were analyzed, and the correlation between self-reported findings and objective parameters of halitosis was assessed. Additionally, the reproducibility of a new organoleptic assessment method was investigated.

MATERIALS AND METHODS

Study Sample

At the Swiss Army base for mechanized and armored troops in Thun, Switzerland, 626 male recruits aged 18 to 25 years (mean: 20.3 years) were selected on the basis of the availability from duty of their army section during the period of basic military training in the third week after being drafted into active service in July 2006. Care was taken to select a sample representative of the young Swiss male population based on information from the Swiss Federal Statistical Office (2006)¹⁵ regarding the different languages and geographical distribution of the Swiss population. All included subjects gave their oral consent to participate in the study that was approved by the institutional review board of the Dental Services of the Army.

The examinations were performed in cohorts of ~20 recruits, totaling ~90 subjects per day for 7 working days. The examinations included an assessment of the prevalence of dental caries based on clinical evaluation and radiographs, the inspection of the oral cavity for stomatologic changes and halitosis,

an assessment of erosive lesions of the hard structures of all teeth, and an evaluation of the functional aspects of the masticatory system.

Questionnaire

Prior to the clinical examination, all subjects were asked to fill out a questionnaire that included 32 questions. Only the following questions were evaluated for the present study:

Known gastroesophageal reflux (yes/no)?

Known salivary gland disease (yes/no)?

Dental hygiene: how many times per day are the teeth brushed? How often is flossing practiced per week (never; up to two times; two to four times; more)?

Consumption of alcoholic beverages: estimate in liters of beer per week?

Smoking: exact amount of cigarettes smoked per day for how many years? This resulted in a pack-year (py) value for each recruit.

How often do you have halitosis (never/rarely/sometimes/often)?

Clinical Parameters

The clinical examination of each recruit started with the organoleptic assessment of halitosis. It was performed by one experienced clinician in a standardized fashion using the index described by Seemann.¹⁶

Grade 3: the recruit was welcomed and seated in the dental chair. The normal distance between the nose of the examiner and the mouth of the subject was ~1 m. If halitosis was noted during speaking, grade 3 was assigned.

Grade 2: the tongue of the recruit was examined. During this procedure a distance of ~30 cm was maintained. If halitosis was detected, grade 2 was assigned.

Grade 1: the recruit kept breathing through his open mouth, and the observer approached to a distance of ~10 centimeters. If halitosis was diagnosed, grade 1 was assigned.

Grade 0: when oral malodor was not detected in any of the steps mentioned above, grade 0 was assigned.

To standardize the procedure and to avoid adaptation of the examiner's sense of smell to possibly detectable odors,¹⁷ there was a break of ~5 minutes between each examination.

In addition to organoleptic measurement, halitosis was assessed with a commercially available VSC monitor.[§] Each recruit held a disposable tube in his mouth and kept breathing through his nose during the measurement. The peak value displayed in parts per billion (ppb) was noted. This procedure was repeated three times for each recruit, and the mean value of the three VSC scores was calculated.

§ Halimeter, Interscan, Chatsworth, CA.

According to the manufacturer, halitosis is present at a VSC value >110 ppb, whereas in the literature, a value of 75 ppb is sometimes used.^{9,18} Both limits of VSC scores were taken into account for the present study.

The oral hygiene of each patient was assessed using the plaque index (PI) of Silness and Løe.¹⁹ For the calculation of PI, all four surfaces of all present teeth were scored. Probing depths (PDs) were determined to the nearest millimeter using a periodontal probe.^{||} For PD, six sites were measured at every tooth: mesio-buccal, buccal, disto-buccal, disto-oral, oral, and mesio-oral. Finally, the tongue coating of each recruit was graded using the following modified grading scale:^{9,20}

Grade 0 = no tongue coating present.

Grade 1 = light coating of the tongue present/~10% of the surface.

Grade 2 = moderate coating of the tongue present/10% to 50% of the surface.

Grade 3 = severe coating of the tongue present/>50% of the surface.

To assess the reproducibility of the new organoleptic assessment method and the VSC measurements, 43 subjects were randomly chosen by drawing lots before the examination of the recruits began. These recruits were reexamined at the end of their cohort with regard to organoleptic assessment of oral malodor and VSC measurements, the examiner being masked to the initial results. To respect the tight time schedule of the study, 43 other recruits, grouped in the same cohort and in line right after the 43 recruits selected for a second evaluation of their clinical parameters, were excluded from the clinical examination.

Statistical Analysis

First, all data were analyzed using descriptive methods.[¶] Next, multiple linear regression analyses were performed to detect potential factors influencing self-reported halitosis, VSC values, and organoleptic gradings. Influencing factors included in the calculation of each dependent variable were subjective data from the questionnaire (toothbrushing, interdental hygiene, salivary gland diseases, gastroesophageal reflux, smoking, and alcohol consumption) and objective findings from the clinical examination (tongue coating, PI, and PD). For PD, the number of pockets ≥ 5 mm per recruit was taken for the regression analysis.

The Pearson correlation coefficient was calculated to evaluate the correlation between self-reported oral malodor assessment, VSC measurements, and organoleptic gradings. For the correlation of the data from the 43 recruits selected for a second clinical examination, VSC values were compared using the Wilcoxon signed-rank test, and organoleptic gradings were compared using the Cohen kappa coefficient.

All analyses were performed using computer software.^{***} The significance level chosen for all statistical tests was $P \leq 0.05$.

RESULTS

Study Population

Six hundred twenty-six recruits filled out the study questionnaire. For the clinical section, 583 recruits were initially included, but three did not participate in the full clinical examination. Therefore, data regarding objective halitosis parameters were available from 580 recruits for further analysis.

Questionnaire Analysis

Gastroesophageal reflux was reported by 28 recruits (4.5% of the study population; $n = 625$; missing data = 1). A salivary gland disease was indicated by five recruits (0.8% of the population; $n = 625$; missing data = 1), but the nature of the disease was not specified.

Most of the recruits reported brushing their teeth twice a day (69%; 411 of 626). This was followed by 27% of the subjects ($n = 163$) brushing three times per day and 8% ($n = 48$) brushing only once. A higher frequency of toothbrushing was reported by four recruits. Therefore, every recruit reported brushing his teeth at least once per day. Flossing was performed by 210 subjects at least once per week, whereas 415 recruits did not practice interdental hygiene (66.4%; $n = 625$; missing data = 1).

Almost 40% of the recruits reported that they did not consume alcohol on a regular basis (39.2%; $n = 617$; missing data = 7). The other study subjects reported an average alcohol intake of 3.1 liters of beer per week (range, 0.1 to 13.0 liters).

Cigarette smoking was reported by 200 recruits (32%). On this basis, the average py index was calculated to be 3 for the smokers and 1 for the overall study population ($N = 626$). The py values ranged from 0 to 13.

Most of the study subjects reported that they suffered rarely from halitosis (63.3%; $n = 390$ recruits; missing data = 10), 110 subjects (17.9%) suffered sometimes from bad breath, and nine subjects (1.5%) reported they experienced halitosis frequently. One hundred seven recruits (17.4%) reported never having experienced oral malodor.

Clinical Findings

Tongue coating was present in 92.6% of the recruits examined (537 of 580 study subjects). Between 10% and 50% of the dorsum of the tongue was coated in about half of the recruits (Table 1).

|| Michigan M1 periodontal probe, Hu-Friedy, Chicago, IL.

¶ Excel Office XP/2000, Microsoft, Redmond, WA.

SAS 9.1, SAS Institute, Cary, NC.

** SPSS 16.0, SPSS, Chicago, IL.

Table 1.**Results of the Grading of Tongue Coating and the Organoleptic Assessment of Halitosis Using the Index According to Seemann¹⁶ (n = 580)**

Tongue Coating		Organoleptic Assessment	
Grade	Subjects (n)	Grade	Subjects (n)
0	43	0	85
1	102	1	339
2	291	2	148
3	144	3	8

The average PI recorded in the recruits was 1.32, with no statistically significant differences among interproximal, oral, and buccal mean values. Nevertheless, a trend toward slightly lower PI scores was noted for buccal tooth surfaces.

The recruits showed a mean PD of 2.15 mm. Proximal and oral surfaces had slightly higher PD values of 2.36 and 2.33 mm, respectively. Buccal surfaces showed a mean PD of 1.64 mm. Twenty-four recruits (3.8%) had a least one site with PD \geq 5 mm (55 sites total).

The organoleptic assessment of oral malodor revealed that ~60% of all subjects (339 of 580) had a grade 1. In ~15% of the recruits (n = 85), the observer did not detect an oral malodor (Table 1). The mean value of the VSC measurements for the 580 recruits included was 69.7 ppb. Two hundred forty-seven subjects had a mean VSC value of \geq 75 ppb (42.6%), and only five subjects (0.9%) had values \geq 110 ppb.

Correlations Among Questionnaire Data, Clinical Factors, and Halitosis Measurements

The multiple regression analysis to detect factors influencing the VSC values revealed two parameters (tongue coating and cigarette smoking) with a significant, but poor, correlation (Table 2). There was an inverse relationship between cigarette smoking and VSC values; i.e., the higher the average py score, the lower the resulting VSC measurement (Fig. 1).

For the organoleptic estimation of halitosis, the regression analysis resulted in two parameters (tongue coating and toothbrushing) with a significant, but poor, correlation (Table 2). The higher the self-reported frequency of toothbrushing per day, the lower the organoleptic grade.

The multiple regression analysis to detect factors influencing the frequency of self-reported halitosis revealed no significant parameters.

Table 2.**Statistically Significant Correlations Among Questionnaire Data, Clinical Factors, and Halitosis Measurements (VSC and organoleptic scores)**

	Estimate	P Value
Correlation of Data With VSC Values		
Tongue coating	2.083	0.0185
Cigarette smoking	-1.113	0.0064
Correlation of Data with Organoleptic Scores		
Tongue coating	0.480	<0.0001
Frequency of toothbrushing	-0.117	<0.0030

Correlation Between Self-Reported and Clinical Data

The calculation of the Pearson correlation coefficient to evaluate the relationships among the three methods (self-reported assessment, VSC readings, and organoleptic rating) of assessing halitosis revealed little to no correlation among the methods. Only the correlation between self-reported oral malodor assessment and the organoleptic method proved to be statistically significant ($P = 0.021$), although the coefficient was very low (0.05).

Reproducibility of the Organoleptic Halitosis Measurements

The analysis of the 43 recruits with repeated measurements revealed almost identical values for organoleptic assessments at the first and second examinations. The VSC measurements at the second examination were generally higher than at the first measurement (Table 3).

DISCUSSION

In the present study, ~20% of the recruits reported suffering at least occasionally from halitosis. Only 107 recruits (17.4%) reported never having experienced oral malodor. Therefore, our study supports findings from other investigators leading to the general assumption that halitosis might be an underestimated oral health problem in the general population.

In a study⁵ interviewing 33,427 persons \geq 15 years of age from all regions of Japan, 14.5% reported problems with oral malodor. Halitosis was the most important oral health concern for 70% of the questioned businessmen from Tokyo. A similar study²¹ from the United States demonstrated that, in a group of patients aged \geq 60 years, 43% reported having chronic or recurrent halitosis, and some even were told that they had breath odor by relatives, friends, or coworkers.

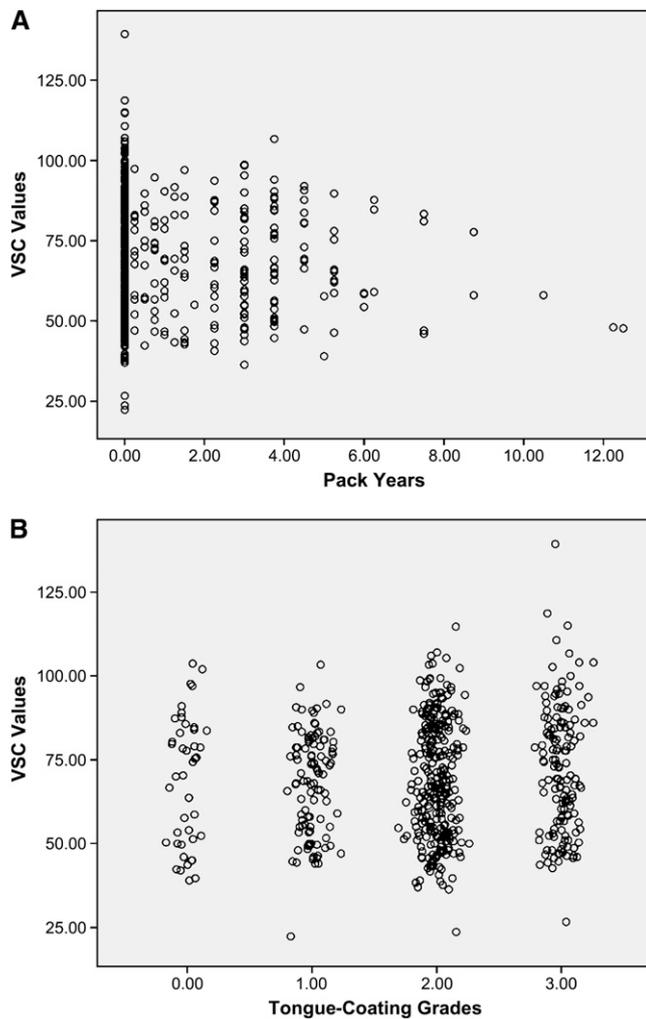


Figure 1.

Scatter plots showing the correlation between VSC values and py index (A) and VSC values and tongue coating (B) for all 580 examined recruits.

Table 3.

Analysis of the Correlation Between Repeated Measurements for VSC Values and Organoleptic Gradings in 43 Recruits

Measurement	Variable	Test	Score	P Value
Organoleptic	Categorical	Kappa coefficient	K = 0.79	<0.0001
VSC	Numeric	Wilcoxon signed-rank	S = -249.5	0.0011

This percentage was even higher than reported for “toothache” or “gum problems.” Data from questionnaires distributed during the annual convention of the American Dental Association in 1995 revealed that

halitosis is a problem frequently encountered by dentists. Ninety-two percent of the dentists reported seeing patients with oral malodor on a regular basis; ~50% saw at least six patients with halitosis per week.⁴

If halitosis poses a major oral health concern in young Swiss adults, as demonstrated by our study, it seems reasonable to speculate that this problem could increase in populations with older average ages. In a recent cross-sectional survey from Rio de Janeiro, Brazil, in which university students were interviewed regarding the prevalence of persistent oral malodor in their households, it was demonstrated that age and gender could be major risk factors.²² The risk for oral malodor was three times higher in people >20 years of age compared to those aged ≤20 years. This is supported by studies from Japan,⁹ China,¹⁰ and Turkey.²³ Although the above-mentioned study²² from Rio de Janeiro also showed that the prevalence of persistent halitosis was nearly three times higher in men, regardless of age, most studies^{7,8,11} demonstrated that men and women seem to be equally affected by halitosis. Therefore, the present data might be used to estimate the degree of concern in terms of bad breath for young adults in Switzerland. However, it was reported that women seem to be more willing to consult health care professionals about their breath odor problems,¹¹ which should be considered when questionnaire studies about oral malodor are performed and their results are interpreted.

Very often, the degree of self-reported halitosis does not correspond to the objective presence of halitosis. This becomes obvious when data from specialized interdisciplinary halitosis clinics are analyzed. In a study carried out in Berlin, Germany, almost 30% of patients complaining that they suffered from halitosis showed no objective detectable signs of oral malodor.²⁴ Also, the data of the present study revealed a negligible degree of correlation between self-reported halitosis and organoleptic measurements and no correlation between self-reported halitosis and halimeter measurements.

Of the 580 recruits included in the present study, 247 subjects (42.6%) had a VSC value ≥75 ppb, and only five subjects presented with values ≥110 ppb. Considerably higher percentages were found in a study from China,¹⁰ with VSC values >110 ppb for 20.3% of the subjects. A study from Japan⁹ found that only 23% of the population had scores >75 ppb; however, the distribution of VSC values >75 ppb was not specified by the investigators. Other threshold measurements for manifest halitosis reported in the literature vary. Reported values include 125,²⁵ ≥150,²⁶ ≥170,²⁷ and ≥200 ppb.²⁸ This wide variation and arbitrary fixing of threshold values makes comparisons of studies difficult. Furthermore, the lack of a universally accepted VSC threshold for the diagnosis of halitosis

could contribute to the differing results with regard to self-reported oral malodor and VSC measurements.

The paradox that patients with positive organoleptic scores may have VSC readings below a defined threshold for oral malodor, whereas others without organoleptically detectable halitosis may have VSC readings above the threshold is well documented in the literature^{6,7,29-35} and is supported by our findings. In the present study, the Pearson correlation coefficient used to compare organoleptic measurements to values from sulphide monitoring revealed no correlation between the two methods. The likely reason for this discrepancy is that other odorants, in addition to VSCs, contribute to halitosis. Examples of these substances are volatile short-chain fatty acids, polyamines, alcohols, phenyl compounds, alkenes, ketones, and nitrogen-containing compounds.^{30,36-38}

Various methods have been described in the literature for estimating the intensity of oral malodor. The most widely used scoring index is the one introduced by Rosenberg et al.,^{6,7} with scores ranging from 0 to 5: 0 = no odor; 1 = barely noticeable odor; 2 = slight but clearly noticeable odor; 3 = moderate odor; 4 = strong odor; and 5 = extremely foul odor. This scoring index has established itself as a gold standard and is used for treatment and research purposes throughout the world.¹ Nevertheless, reliability and reproducibility are problematic with this index,¹ and efforts have been made to simplify it.³⁹ Intra- and interobserver variations are also a frequent finding; therefore, training and calibration of breath odor judges are needed for standardized examinations.^{1,40} Even the initial study by Rosenberg et al.⁷ demonstrated a low inter- and intraexaminer consistency when performing organoleptic measurements, with kappa scores of 0.38 and 0.22, respectively.

For the present epidemiologic study, an index with fewer grades and a special emphasis on the distance at which oral malodor is detected by the clinician was chosen. This scoring system has been used for several years in a specialized bad breath clinic.¹⁶ In the present study, the reproducibility of this test was demonstrated by the high kappa values found for the repeated examination of 43 randomly selected subjects (Table 3). Nevertheless, the present study failed to demonstrate a significant correlation between the organoleptic score used and VSC measurements. It seems that the index used was unable to detect higher VSC levels in the recruits tested, indicating objective halitosis. Therefore, the organoleptic score presented in this study should not be used as the organoleptic method of choice to measure and assess halitosis. Furthermore, a validated organoleptic scoring system, like the "Rosenberg" index, should always be included as a control when evaluating new indices in future studies.

About one-third of the interviewed recruits reported smoking cigarettes on a regular basis. The self-reported py values calculated from the questionnaire data ranged from 0 to 13. In a recent study⁴¹ of a representative Swiss population in 1993 (n = 19,617) and 2003 (n = 20,400), the prevalence of 20-year-old male smokers was assessed. That study revealed an increase in daily and weekly tobacco use from 37.1% to 46.7% over the 10-year period. However, the prevalence of smokers was clearly lower in the present study.

The role of smoking in the etiology of halitosis has been mainly defined as an extrinsic cause, as opposed to an actual intra-/extraoral somatic cause for oral malodor.⁴² In the literature, the subjective feeling of having halitosis as a result of cigarette smoking is termed "smoker's breath."⁴³ Correlations between self-reported halitosis and smoking can be found, especially when data are based on questionnaires.²³ Cigarette smoke contains a VSC that can be detected by the halimeter.^{43,44} However, the concentration of detectable VSC should strongly depend on the time elapsed since the last cigarette. This might explain why correlations between cigarette smoking and VSC scores show conflicting results. Miyazaki et al.⁹ demonstrated a statistically significant Spearman correlation coefficient (0.249; $P < 0.001$) between smoking and higher VSC values, whereas lower VSC values have also been reported in smokers compared to non-smokers.⁴⁵ In the present study, cigarette smoking was inversely correlated with VSC readings, and no correlation could be found between smoking and organoleptic measurements.

Among healthy individuals with no history of periodontal disease, the dorsum of the tongue is known to be a major site for the production of VSC due to bacterial colonization.^{9,15,46} Results from studies⁴⁷⁻⁴⁹ focusing on the treatment of halitosis through tongue cleaning, especially the posterior part of the dorsum of the tongue, demonstrated that VSC scores can be significantly reduced. In the present study, multiple regression analysis revealed tongue coating to be a statistically significant factor influencing the VSC values ($P = 0.0185$) and organoleptic measurements ($P < 0.0001$). The frequency of toothbrushing was the only other significant factor influencing organoleptic scores in the present population ($P < 0.003$).

Because of the slow, progressive, and chronic nature of periodontitis,⁵⁰ it was unlikely that 20-year-old recruits would be diagnosed with fully developed periodontitis. This is represented by the low PD values of our study, which did not correlate with positive organoleptic gradings or higher VSC readings. No fully developed periodontitis or aggressive periodontitis was diagnosed in the present population. PI as an indicator of objective oral hygiene was chosen as a

potential influencing factor for oral malodor. Although the mean PI score for the recruits examined was >1 , there was no correlation with VSC or organoleptic findings. It has been reported in the literature that the biofilm present at the time of examination seems not to significantly influence VSC values and organoleptic scores.^{29,51} With regard to the findings in our study, there is a need for further research to more clearly understand the roles of dental plaque and periodontal disease and their relationship to oral malodor.^{29,52,53}

CONCLUSIONS

For about one-fifth of 20-year-old Swiss males questioned, oral malodor posed an oral health problem. No correlation could be detected between self-reported halitosis and organoleptic or VSC measurements. Tongue coating was the only factor found to contribute to higher organoleptic scores and VSC values. The modified organoleptic method described in this study was unable to detect higher VSC levels in the recruits tested, indicating objective halitosis. Therefore, the organoleptic score presented in this study should not be used as the organoleptic method of choice to measure and assess halitosis.

ACKNOWLEDGMENTS

The cooperation of Colonel Kurt Jäger, Chief of the Dental Services of the Army, and the technical support of the Pharmacy of the Army are greatly appreciated. Thanks are also due to the officers, subofficers, and recruits of the Recruit School Pz Trp RS 21-2. Many thanks are due to the Surgeon General of the Swiss Army, Div. Gianpiero Lupi. The authors express their special gratitude to Lieutenant-Colonel Niklaus P. Lang for the organization and supervision of this investigation in the summer of 2006 in Thun, Switzerland. We also thank Dr. Giovanni Salvi, Department of Periodontics, School of Dental Medicine, University of Bern, for his support in evaluating the periodontal data of our study. The study was supported by University of Bern departmental funds. The authors report no conflicts of interest related to this study.

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- Submitted June 6, 2008; accepted for publication September 10, 2008.