

THOMAS BIGLER
ANDREAS FILIPPI

Clinic for Dental Surgery, Dental Radiology, and Dentistry, University Dental Clinics, University of Basel, Switzerland

CORRESPONDENCE

Prof. Dr. Andreas Filippi
Klinik für Zahnärztliche
Chirurgie, –Radiologie,
Mund- und Kieferheilkunde,
Universitätskliniken für
Zahnmedizin, Universität Basel
Hebelstrasse 3
4056 Basel
Tel. 061 267 26 10
Fax 061 267 26 07
E-mail: andreas.filippi@
unibas.ch

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Importance of halitosis

A survey of adolescents and young adults

KEYWORD

halitosis

SUMMARY

Over the last few years, halitosis has become an increasingly important issue for dentists and their patients.

For this study, a questionnaire was distributed in four different vocational/vocational-technical schools in Zurich to find out more about the personal oral hygiene and general knowledge of halitosis of 888 young women and 921 young men between the ages of 15 and 25. The factors of gender, education, professional customer contact, age and size of the residential community were taken into account. Findings were presented on the basis of a visual analogue scale.

The survey results showed women to have a more intensive oral hygiene regimen and more frequent check-ups than their male counter-

parts ($p < 0.001$). Bad breath was also seen to be a more important issue to women who took more measures against it ($p < 0.001$). Education and customer contact both had an influence on the perceived importance of halitosis, as well as on the knowledge of possible measures against it ($p < 0.001$).

However, the age of those surveyed and the size of their respective communities did not seem to have an impact ($p > 0.05$).

The analysis showed that halitosis is an important issue for young people, and that a large part of the young population sees tongue cleaning as a part of oral hygiene and intraoral change as a cause of halitosis.

Introduction

Most people have dealt with the issue of halitosis personally or in others. Halitosis often develops due to changes in the oral cavity, such as a thick tongue coating, or a change in the bacterial milieu due to periodontitis marginalis and gingivitis (DELANGHE ET AL. 1997, LANG & FILIPPI 2004, SEEMANN ET AL. 2006, BORNSTEIN ET AL. 2009A, CALIL ET AL. 2009, QUIRYNEN ET AL. 2009, ZÜRCHER & FILIPPI 2012, VAN TORNOUT ET AL. 2013).

Especially gram-negative anaerobic bacteria are found to be responsible for causing halitosis, should the cause be intraoral (TONZETICH 1977, MORITA & WANG 2001B). The bacterial disintegra-

tion of food residue, epithelial residue, and blood and saliva components leads to volatile sulfur compounds (VSC) and other odoriferous substances (PERSSON ET AL. 1990, GOLDBERG 1994, MORITA & WANG 2001B).

In young patients, the tongue seems to be one of the most common sources of halitosis, whereas a combination of periodontal disease, tongue coating, and a reduced flow of saliva is more commonly found to cause halitosis in older people (MIYAZAKI ET AL. 1995).

Regular cleaning of the tongue reduces the tongue coating, and thus also reduces the amount of VSC in the exhaled air (VAN

DER SLEEN ET AL. 2010, AMOU ET AL. 2014). Although a toothbrush can of course be used to clean the tongue, it is recommended to use a special tongue cleaner, because it is more effective than a toothbrush (QUIRYNEN ET AL. 2002, OUTHOUSE ET AL. 2006).

84.7% of the patients presenting with real halitosis at the University Dental Clinic, Basel, had considerable tongue coating, 19.3% had periodontitis marginalis, and 15.3% had gingivitis (ZÜRCHER & FILIPPI 2012).

Caries, insufficient oral hygiene, open root canals, periimplantitis, interdental plaque, infections such as stomatitis or candidiasis, and poorly cared-for dentures are further causes of halitosis (LANG & FILIPPI 2004, ROSENBERG 2006, VAN DEN BROEK ET AL. 2007).

The most common extraoral causes of halitosis lie in the ear-nose-throat area, and make up between 2% and 8% of the cases. The most frequent pathological change is chronic tonsillitis. Many people still consider the stomach to be the source of halitosis, but the gastrointestinal tract is in fact involved in only 1% of the cases (DELANGHE ET AL. 1997, SEEMANN ET AL. 2006, QUIRYNEN ET AL. 2009, ZÜRCHER & FILIPPI 2012). Since the cause of halitosis is usually found in the oral cavity, dentists should check there first (FILIPPI & MÜLLER 2006).

Often, no direct relationship between smoking and an increased VSC concentration can be found (MORITA & WANG 2001A, FILIPPI & MÜLLER 2006). The exhaled smoke components as well as the particles of tobacco smoke that are deposited on the mucous membranes and teeth cause so-called smoker's breath, which overpowers the normal smell of the exhaled air. However, smokers' increased tendency to accumulate plaque and their decreased saliva flow are risk factors for halitosis (CHRISTEN 1992). In Switzerland, about 30% of the male and 24% of the female population smoke (MORGER ET AL. 2010, KELLER ET AL. 2011).

A number of epidemiological studies from different countries show that the prevalence of halitosis lies at about 25% (AL-ANSARI ET AL. 2006, LIU ET AL. 2006, BORNSTEIN ET AL. 2009B, BOLLEN & BEIKLER 2012). According to current data, there is no difference in prevalence or intensity of halitosis between men and women (MIYAZAKI ET AL. 1995, QUIRYNEN ET AL. 2009, YOKOYAMA ET AL. 2010, ZÜRCHER & FILIPPI 2012, AMOU ET AL. 2014). However, it is known that women have a higher awareness of health, and thus brush and floss their teeth and come to check-ups more often (RONIS ET AL. 1993, FURUTA ET AL. 2011, STADELMANN ET AL. 2012). Only one study in Brazil found that being male and above the age of 20 were risk factors for halitosis (NADANOVSKY ET AL. 2007). Other studies found that age had no influence on halitosis (MIYAZAKI ET AL. 1995, QUIRYNEN ET AL. 2009).

How important the topic of halitosis is for adolescents and young adults in Switzerland, and what measures they take against it, has not yet been discussed in the literature. Using a questionnaire, the difference between young men and young women concerning the importance of and knowledge on halitosis, and measures taken against it, were examined. Additionally, the influence of education, age, size of the community in which they live, and job-related customer contact were taken into account.

Materials and Methods

In the summer of 2012, 1,816 women and men between the ages of 15 and 25 (criteria of inclusion) from four different vocational schools in Zürich were surveyed on the topic of halitosis.

The test included 16 questions, of which four could be supplemented by information on frequency. There were several

possible answers to one question. The importance of halitosis was determined using a visual analogue scale 10 cm in length (evaluation in mm, Tab. I).

The surveys were conducted at the Zurich Vocational School of Fashion and Design, the Zurich Vocational School of Construction, and the Zurich Vocational School of Technology, Business, and Health and Social Services. The Vocational School of Construction consists of two independent departments: "Installation and Outfitting" and "Planning and Shell Construction".

Those surveyed lived either in Switzerland or the principality of Liechtenstein, and were (soon-to-be) apprentices. The questionnaires were filled out independently and anonymously after brief instruction by one and the same instructor.

After excluding seven people who were above the age of 25, 1,809 questionnaires were entered into an Excel table (Microsoft Office 2011). The vocations were divided into three different educational levels. The highest level, "BMS", involves acquiring a vocational-technical diploma in addition to the apprenticeship certificate, allowing the graduate to attend university. For instance, this group included structural draftsmen or specialized health-sector employees.

The middle educational level, the "planners", included professions such as structural draftsmen or draftsmen who specialized in planning buildings. The "craftsmen" professions are important on construction sites, or are required to have other manual skills, such as mason, carpenter, hairdresser, or florist.

The vocations were also divided according to customer contact. Apprentices who had direct customer contact were assigned to the group "close customer contact", for example hairdressers or beauticians. The other apprentices were placed in the group "normal customer contact".

All calculations were done using the statistics program R (version 2.15.1) (R DEVELOPMENT CORE TEAM 2011). For the categorical parameters, a cross table with number of cases and percentages was generated. P-values were calculated using the Chi-square or Fisher's Exact Test (for a small number of cases). Ordinally scaled parameters were analyzed with the non-parametric Wilcoxon or Kruskal-Wallis rank-sum test. For all tests, the error probability was set at 0.05 as the (two-sided) significance level. Due to the descriptive nature of the study, no adjustments were made after multiple comparisons.

Results

After excluding seven questionnaires on which the age of the participants was missing, the data of 888 women (49.1%) and 921 (51.9%) men between the ages of 15 and 25 were evaluated. The average age was 17.7 years and the median was 18 years.

Tobacco and alcohol

The number of smokers was about the same among men and women (women: 37.2%, n=328; men: 39.0%, n=356; p=0.48, 14 missing answers).

Concerning alcohol consumption, the difference between men and women was more pronounced (p<0.001). 30.5% of the women (n=267) claimed to never consume alcohol, with 59.3% (n=519) doing so once a week. 19.4% (n=177) of the men were abstinent, and 49.4% (n=451) drank once a week. 10.2% of the women (n=89) and 29.1% of the men (n=266) consumed alcohol two to three times a week. 2.1% of the men (n=19) and 0.1% of the women (n=1, 20 no response) consumed alcohol daily.

Tab.1 The 16 questions and possible answers

1. Age	
2. Gender	Female, male
3. Nationality	
4. Were you born in Switzerland?	Yes, no
5. How many people live in your community?	Less than 1,000, 1,001–5,000, 5,001–10,000, more than 10,000
6. Do you smoke cigarettes?	No; yes; if so, how many per day?
7. How often do you drink alcohol?	Never, 1× per week, 2–3× per week, every day
8. How many times per day do you brush your teeth?	1×, 2×, 3×, 4×
9. Do you use dental floss or interdental brushes?	No; yes; if so, how often per week?
10. Do you use mouthwash?	No; yes; if so, how often per week?
11. Do you clean your tongue?	No; yes; if so, how often per week? If so, how? tooth brush, tongue cleaner
12. How often do you go to dental check-ups? (Dentist or DH)	Less than every 3 years, every 3 years, every 2 years 1× per year, 2× per year, 3× per year
13. What do you consider to be the most important cause of halitosis?	Stomach problems, sinus, food residue in the interdental spaces, gingivitis, tongue coating, caries
14. Which measures do you take against halitosis?	Nothing, chewing gum, lozenge, mouthwash, clean tongue, brush teeth, breath spray (multiple answers)
15. If faced with constant halitosis, who would you consult first?	General practitioner, gastroenterologist, ear–nose–throat specialist, dentist
16. How important is it to you that your partner doesn't have halitosis?	10–cm–long visual analog scale from “not important” (0 mm) to “very important” (100 mm)

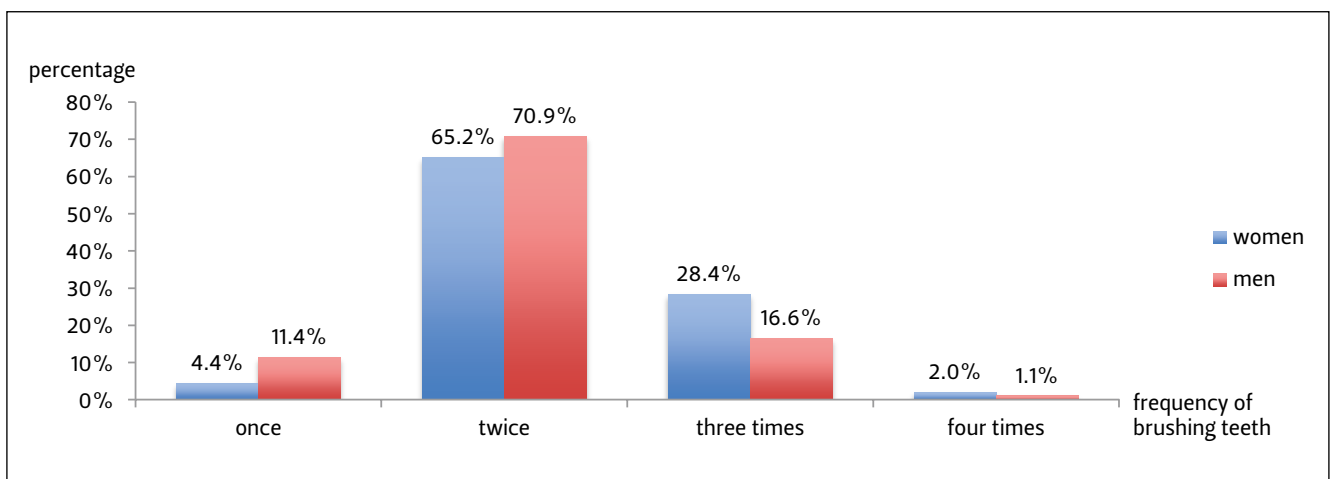
Oral hygiene

Women brush their teeth more often ($p < 0.001$, 1 no response, Fig. 1), and they use dental floss or interdental brushes more often than do men (women: 43.4%, $n = 385$; men: 31.4%, $n = 289$; $p < 0.001$, 13 no response). Furthermore, they also use mouthwash more often (women: 56.6%, $n = 503$; men: 46.0%, $n = 424$; $p < 0.001$, 15 no response).

In total, 57.1% of those surveyed claimed that they cleaned their tongue (women: 64.9%, $n = 573$; men: 49.5%, $n = 453$; 11 no

response). Women cleaned their tongue more often than men ($p < 0.001$), and both genders used their toothbrushes in 81.2% of the cases to do so ($p = 0.99$, 59 no response).

60.2% of the people ($n = 1,089$) attended the annual check-up, 19.3% ($n = 349$) had check-ups two to three times a year, 14.5% ($n = 263$) went every two to three years, and 5.4% ($n = 98$) frequented the dentist or a dental hygienist less than every three years (10 no response). In total, women had check-ups more often than did men ($p = 0.005$).

**Fig.1** Frequency of brushing teeth ($n = 1808$)

Halitosis

Men and women largely named the same factor as the most important cause of halitosis (Fig. 2).

Women differ from men in terms of how important it is to them that their partner does not have bad breath ($p < 0.001$). Women had a median of 95 mm on the visual analogue scale (interquartile distance: 82 mm, 100 mm), and men 89 mm (75 mm, 100 mm).

Faced with constant halitosis, 75.3% ($n = 1362$) of those surveyed would have gone to a dentist, 19.9% ($n = 359$) to a general practitioner, 2.8% ($n = 50$) to a gastroenterologist, and 1.2% to an ear-nose-throat specialist ($n = 21$, 17 no response). More women would have gone to a dentist, and more men would have sought the help of a general practitioner ($p < 0.001$).

When experiencing bad breath, almost 86% of the vocational students chewed gum, and about 82% brushed their teeth (Fig. 3, multiple answers possible).

There were no age-related differences concerning the importance of their partner not having halitosis, the frequency of

tongue cleaning, or knowledge about halitosis. The size of the community in which they lived also did not seem to have an effect on knowledge about, the importance of, and measures taken against halitosis ($p > 0.05$).

Education

When dividing the pool of individuals surveyed into the different educational levels, 49.0% ($n = 886$) were categorized as “craftsmen”, 30.2% ($n = 547$) as “planners”, and 20.8% ($n = 376$) as vocational-technical diploma candidates.

There were differences concerning knowledge about halitosis ($p < 0.001$). 46.1% ($n = 173$) of those with the highest level of education, “vocational-technical diploma”, thought that tongue coating was the cause of halitosis, and 86.1% believed the cause to be intraoral. Only 33.2% ($n = 292$) of the “craftsmen” thought of tongue coating as the cause, and 21.7% ($n = 191$) saw the stomach as the source of halitosis.

“Craftsmen”, however, cleaned their tongues more often than did those from the “vocational-technical diploma” level

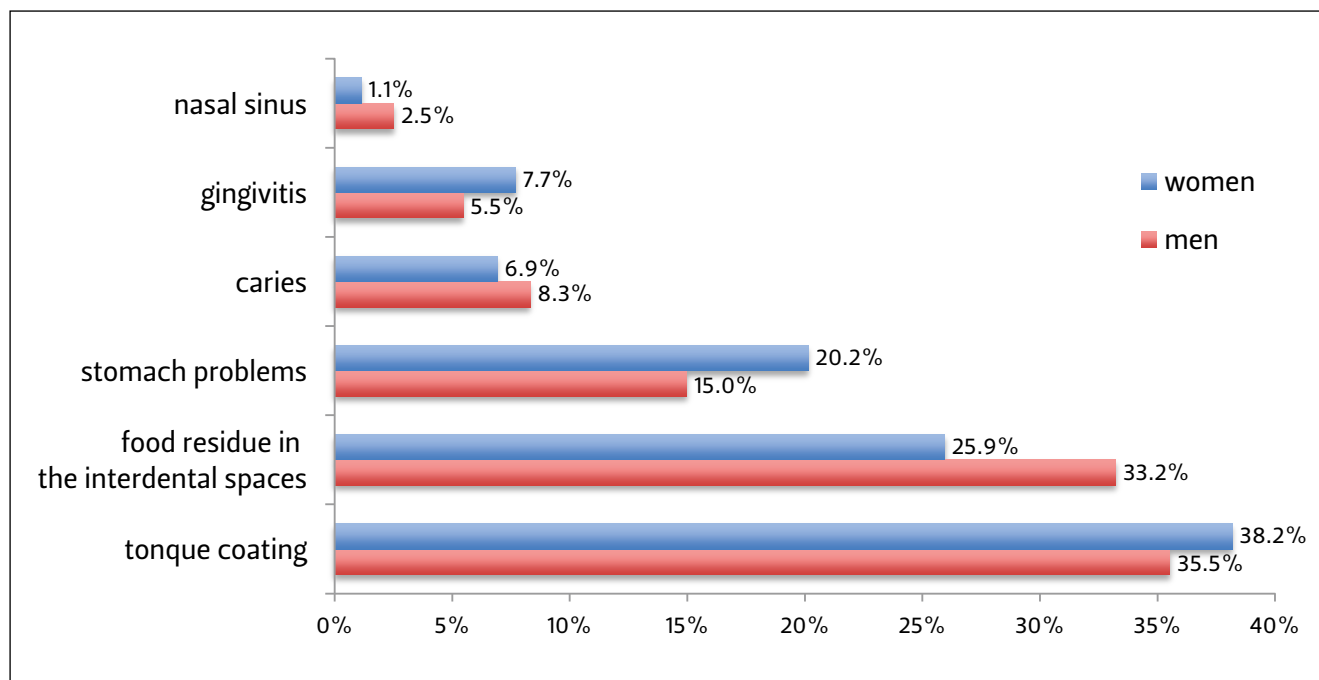


Fig. 2 Most important cause of halitosis ($n = 1798$)

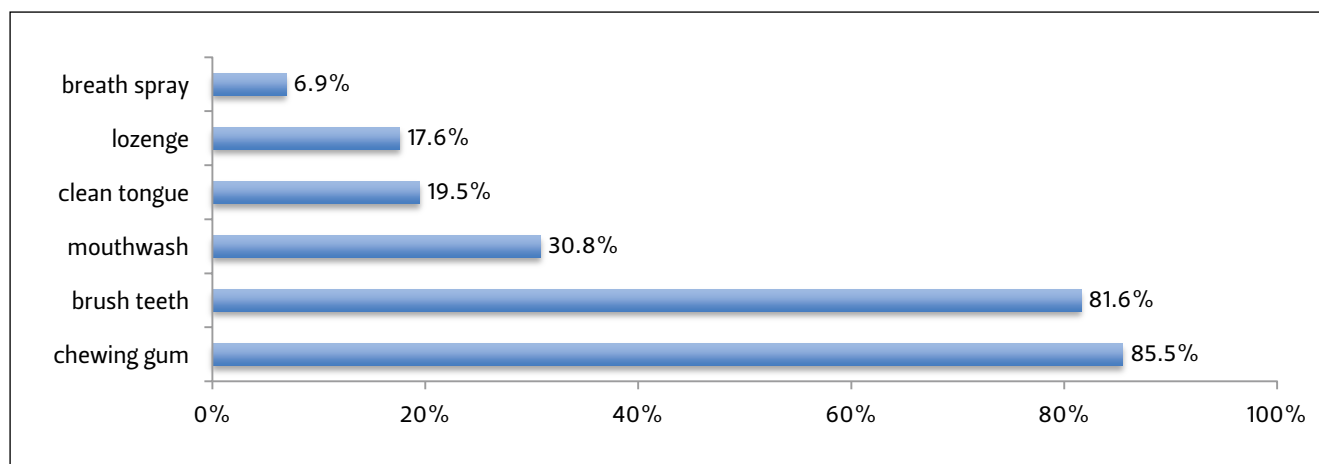


Fig. 3 Measures taken against halitosis (multiple answers)

(64.4% vs. 48.5%, $p < 0.001$), and it was more important to them that their partner did not have halitosis ($p < 0.001$). The “planners” had average scores for these items.

The three educational levels varied in terms of tobacco consumption: 52.3% ($n = 459$) of the “craftsmen” were smokers, whereas 30.4% ($n = 165$) of the “planners” and 16.0% ($n = 60$) of the “vocational-technical diploma” group smoked ($p < 0.001$).

Consumer contact

573 people (31.7%) were assigned to the group “close customer contact”. With a median of 97 mm (interquartile distance: 86 mm, 100 mm), it was more important to these people that their partner did not have halitosis than it was to those in the group with “normal customer contact” (median: 89 mm, interquartile distance: 76 mm, 100 mm, $p < 0.001$).

Individuals with close customer contact cleaned their tongues very often (70.0%, $n = 397$; normal customer contact: 51.1%, $n = 629$, $p < 0.001$), and brushed their teeth more often than people with normal customer contact ($p < 0.001$).

Compared to the students with normal customer contact, more of the students with close customer contact brushed their teeth three to four times a day (30.9% vs. 20.7%), and fewer of them (compared to those with normal customer contact) brushed their teeth just once a day (4.6% vs. 9.6%).

Discussion

In the present study, the percentage of women and men was fairly even (49.1% and 50.9%). With an average age of 17.7 years and a median of 18 years, most of those surveyed were under the age of 20.

Tobacco and alcohol

This study showed that, compared to the national average, this group of people had a higher percentage of smokers. However, as already shown in a different study, the percentage of smokers among apprentices and people aged 15–25 is higher than the national average (KELLER ET AL. 2011).

Men drank more alcohol (frequency and amount) than women ($p < 0.001$), as was also found in another study in Zurich (HAUG ET AL. 2013).

Oral hygiene

As shown in other studies, women practiced oral hygiene more intensively than did men. They brushed their teeth more frequently and used dental floss/interdental brushes more often (RONIS ET AL. 1993, STADELMANN ET AL. 2012, FURUTA ET AL. 2011). Furthermore, in this study, they used mouthwash more commonly, cleaned their tongue more often (each $p < 0.001$), and went to the dentist or DH for check-ups more frequently ($p = 0.005$).

57.1% of those surveyed, and almost 65% of the women, claimed that they cleaned their tongue. Thus, people cleaned their tongue more often than they used mouthwash or dental floss/interdental brushes, although 81.2% used their toothbrush to do so, which is considered to be less effective than using a tongue cleaner (OUTHOUSE ET AL. 2006). The awareness that tongue cleaning is part of good oral hygiene has been observed in a large part of the young Swiss population.

Halitosis

The high scores on the visual analogue scale prove that halitosis is an important issue for young adults in Switzerland. The pop-

ulation seems to have been made aware of it through prevention and media presence. Most of those surveyed (75.3%) would have consulted a dentist for constant halitosis, and 80.6% believed an intraoral change to be the most important cause of halitosis.

Women used more kinds of tools against halitosis and they used them more often. Most people used chewing gum (85.5%), which, however, only covers the smell and does not last very long (REINGEWIRTZ ET AL. 1999). Only a few still use breath spray.

Only 19.5% cleaned their tongue in order to freshen their breath. This suggests that most of those who cleaned their tongues regularly (57.1%) do not do so because of halitosis. A large number of the adolescents questioned cleaned their tongues, yet this was not primarily associated with halitosis.

Although there is no data on the frequency of tongue cleaning in the Swiss population, it does seem that today adolescents clean their tongue more often than in the past. Through advertisements and prevention, a large part of the population seems to know that the tongue should be cleaned, but chewing gum is still preferred to fight halitosis.

Education

Those with a higher level of education more often named an intraoral change as the cause of halitosis, yet they took fewer measures against it. It seemed of less importance to them than to those with other levels of education in terms of selecting a partner.

Significant differences were observed between the educational levels in terms of the percentage of smokers ($p < 0.001$). In agreement with another study, it was found that tobacco consumption is dependent upon education and other socioeconomic factors (CHEAH & NAIDU 2012). A survey by the Institute for Psychology at the University of Zurich showed that more people with less school education smoke (KELLER ET AL. 2011).

The category “craftsmen” is comprised largely of trades in construction, which are typically practiced almost exclusively by men. Other trades, however, are practiced mainly by women, which made a comparison with the two other groups difficult.

Age and size of community

The size of the community did not seem to have any influence on the factors examined. In the canton of Zurich, the differences between cities and rural areas are less pronounced than in other cantons in Switzerland.

No difference was found between the age groups 15–19 years and 20–25 years. However, since only 13.3% ($n = 241$) of the people questioned were between 20 and 25 years old (average age: 17.7 years, median: 18 years), this was not an even distribution.

Customer contact

The group with “close customer contact” made considerably greater efforts to prevent halitosis by brushing their teeth more frequently and cleaning their tongue. Furthermore, it was very important to them that their partner did not have halitosis.

Working close to customers seems to have an influence on the importance of halitosis and the measures taken against it. Nevertheless, almost 25% of the group thought the stomach was the most important cause of halitosis.

The categorization according to customer contact only included the health and social services, garment designers, assistant hairdressers, hairdressers and beauticians, professions

which were practiced by about a third of those surveyed. The group with “close customer contact” consisted of 90.8% women and 78.5% “craftsmen”, which is not an even distribution between gender and vocational field. Thus, female gender and the vocational field “craftsmen” could explain these results.

Conclusion

Halitosis seems to be an important issue for adolescents and young adults.

As proven by other studies, women brush their teeth, use dental floss, and attend check-ups more often than men (RONIS ET AL. 1993, STADELMANN ET AL. 2012). Additionally, more of them use mouthwash and they clean their tongue more often.

Most of those surveyed associate halitosis with intraoral changes such as tongue coating or food residue in the interdental spaces. When faced with constant halitosis, most would consult a dentist.

Thus, most people associate halitosis with the dentist and oral hygiene. Future prevention campaigns should emphasize that using a toothbrush for tongue cleaning is less effective than using a tongue cleaner.

Acknowledgements

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Résumé

Le sujet de l’halitose a gagné de plus en plus d’importance aux yeux des dentistes et de leurs patients au cours de ces dernières années.

Dans quatre écoles professionnelles différentes de Zurich, 888 femmes et 921 hommes entre 15 et 25 ans ont été interrogés à l’aide d’un questionnaire concernant leur avis personnel au sujet de l’hygiène bucco-dentaire, ainsi que leurs connaissances au sujet de l’halitose. Le genre, l’éducation, le contact avec la clientèle, l’âge et la taille de la commune de domicile ont été pris en considération. L’importance du sujet a été relevée à l’aide d’une échelle analogue visuelle.

Les femmes avaient une hygiène buccodentaire plus intense que les hommes et faisaient contrôler leurs dents plus souvent ($p < 0.001$). La mauvaise haleine avait plus d’importance pour les femmes que pour les hommes et par conséquent, elles entreprenaient plus de mesures contre ce phénomène ($p < 0.001$). L’éducation et le contact avec la clientèle avaient tous une influence sur l’importance de la mauvaise haleine, les connaissances à ce sujet et les mesures prises à son encontre ($p < 0.001$). L’âge des personnes interrogées et leur commune de domicile ne semblaient cependant avoir aucune influence concernant les différences ($p > 0.05$).

L’analyse a montré que l’halitose est un sujet important pour la population jeune et qu’une grande partie de jeunes considèrent le nettoyage de la langue comme faisant partie de l’hygiène bucco-dentaire et que les changements en bouche sont à l’origine de la mauvaise haleine.

References

- AL-ANSARI J M, BOODAI H, AL-SUMAIT N, AL-KHABBAZ A K, AL-SHAMMARI K F, SALAKO N: Factors associated with self-reported halitosis in Kuwaiti patients. *J Dent* 34: 444–449 (2006)
- AMOU T, HINODE D, YOSHIOKA M, GRENIER D: Relationship between halitosis and periodontal disease – associated oral bacteria in tongue coatings. *Int J Dent Hyg* 12: 145–151 (2014)
- BOLLEN C M, BEIKLER T: Halitosis: the multidisciplinary approach. *Int J Oral Sci* 4: 55–63 (2012)
- BORNSTEIN M M, STOCKER B L, SEEMANN R, BÜRGIN W B, LUSSI A: Prevalence of halitosis in young male adults: a study in Swiss army recruits comparing self-reported and clinical data. *J Periodontol* 80: 24–31 (2009a)
- BORNSTEIN M M, KISLIG K, HOTI B B, SEEMANN R, LUSSI A: Prevalence of halitosis in the population of the city of Bern, Switzerland: a study comparing self-reported and clinical data. *Eur J Oral Sci* 117: 261–267 (2009b)
- CALIL C, LIBERATO F L, PEREIRA A C, DE CASTRO MEGHIM M, GOODSON J M, GROppo F C: The relationship between volatile sulphur compounds, tongue coating and periodontal disease. *Int J Dent Hyg* 7: 251–255 (2009)
- CHEAH Y K, NAIDU B M: Exploring factors influencing smoking behaviour in Malaysia. *Asian Pac J Cancer Prev* 13: 1125–1130 (2012)
- CHRISTEN A G: The impact of tobacco use and cessation on oral and dental diseases and conditions. *Am J Med* 93: 25–31 (1992)
- DELANGHE G, GHYSELEN J, VAN STEENBERGHE D, FEENSTRA L: Multidisciplinary breath-odour clinic (letter). *Lancet* 350: 187 (1997)
- FILIPPI A, MÜLLER N: Echte und psychisch bedingte Halitosis – Befunde, Diagnosen und Ergebnisse einer Mundgeruch-Sprechstunde. *Schweiz Monatsschr Zahnmed* 116: 129–135 (2006)
- FURUTA M, EKUNI D, IRIE K, AZUMA T, TOMOFUJI T, OGUURA T, MORITA M: Sex differences in gingivitis relate to interaction of oral health behaviors in young people. *J Periodontol* 82: 558–565 (2011)
- GOLDBERG S, KOZLOVSKY A, GORDON D, GELERTER I, SINTOV A, ROSENBERG M: Cadaverine as a putative component of oral malodor. *J Dent Res* 73: 1168–1172 (1994)
- HAUG S, SCHAUB M, GROSS C, JOHN U, MEYER C: Predictors of hazardous drinking, tobacco smoking and physical inactivity in vocational school students. *BMC Public Health* 13: 475 (2013)
- KELLER R, RADTKE T, KREBS H, HORNUNG R: Der Tabakkonsum der Schweizer Wohnbevölkerung in den Jahren 2001 bis 2010. *Tabakmonitoring – Schweizerische Umfrage zum Tabakkonsum*. Zürich: Psychologisches Institut der Universität Zürich, Sozial- und Gesundheitspsychologie (2011)
- LANG B, FILIPPI A: Halitosis – Epidemiologie und Entstehung. *Schweiz Monatsschr Zahnmed* 114: 1037–1050 (2004)
- LIU X N, SHINADA K, CHEN X C, ZHANG B X, YAEGAKI K, KAWAGUCHI Y: Oral malodor-related parameters in the Chinese general population. *J Clin Periodontol* 33: 31–36 (2006)
- MIYAZAKI H, SAKAO S, KATOH Y, TAKEHARA T: Correlation between volatile sulphur compounds and certain oral health measurements in the general population. *J Periodontol* 66: 679–684 (1995)
- MORGER R, RAMSEIER C A, REES T D, BÜRGIN W B, BORNSTEIN M M: Oral mucosal findings related to tobacco use and alcohol consumption: A study on Swiss army recruits involving self-reported and clinical data. *OHPD* 8: 143–151 (2010)
- MORITA M, WANG H L: Relationship between sulcular sulfide level and oral malodor in subjects with periodontal disease. *J Periodontol* 72: 79–84 (2001a)
- MORITA M, WANG H L: Association between oral malodor and adult periodontitis: a review. *J Clin Periodontol* 28: 813–819 (2001b)
- NADANOVSKY P, CARVALHO L B, PONCE DE LEON A: Oral malodor and its association with age and sex in a general population in Brazil. *Oral Dis* 13: 105–109 (2007)
- OUTHOUSE T L, AL-ALAWI R, FEDOROWICZ Z, KEENAN J V: Tongue scraping for treating halitosis. *Cochrane Database Syst Rev* 2: CD005519 (2006)
- PERSSON S, EDLUND M B, CLAESSON R, CARLSSON J: The formation of hydrogen sulfide and methyl mercaptan by oral bacteria. *Oral Microbiol Immunol* 5: 195–201 (1990)
- QUIRYNEN M, DADAMIO J, VAN DEN VELDE S, DE SMIT M, DEKEYSER C, VAN TORNOUT M, VANDEKERCKHOVE B: Characteristics of 2000 patients who visited a halitosis clinic. *J Clin Periodontol* 36: 970–975 (2009)
- QUIRYNEN M, ZHAO H, VAN STEENBERGHE D: Review of the treatment strategies for oral malodour. *Clin Oral Invest* 6: 1–10 (2002)
- R DEVELOPMENT CORE TEAM: R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3–900051–07–0, URL www.R-project.org (2011)
- REINGEWIRTZ Y, GIRAULT O, REINGEWIRTZ N, SENGER B, TENENBAUM H: Mechanical effects and volatile sulfur compound-reducing effects of chewing gums: comparison between test and base gums and a control group. *Quintessence Int* 30: 319–323 (1999)
- RONIS D L, LANG W P, FARGHALY M M, PASSOW E: Tooth brushing, flossing, and preventive dental visits by Detroit-area residents in relation to demographic and socioeconomic factors. *J Public Health Dent* 53: 138–145 (1993)
- ROSENBERG M: Bad breath and periodontal disease: how related are they? *J Clin Periodontol* 33: 29–30 (2006)
- SEEMANN R, BIZHANG M, DYEMCHIDI C, KAGE A, NACHNANI S: The proportion of pseudo-halitosis patients in a multidisciplinary breath malodour consultation. *Int Dent J* 56: 77–81 (2006)
- STADELMANN P, ZEMP E, WEISS C, WEIGER R, MENGHINI G, ZITZMANN N U: Dental visits, oral hygiene behaviour, and orthodontic treatment in Switzerland. *Schweiz Monatsschr Zahnmed* 122: 104–111 (2012)
- TONZETICH J: Production and origin of oral malodor: a review of mechanisms and methods of analysis. *J Periodontol* 48: 13–20 (1977)
- VAN DEN BROEK A M, FEENSTRA L, DE BAAT C: A review of the current literature on aetiology and measurement methods of halitosis. *J Dent* 35: 627–635 (2007)
- VAN DER SLEEN M I, SLOT D E, VAN TRIJFFEL E, WINKEL E G, VAN DER WEIJDEN G A: Effectiveness of mechanical tongue cleaning on breath odour and tongue coating: a systematic review. *Int J Dent Hyg* 8: 258–268 (2010)
- VAN TORNOUT M, DADAMIO J, COUCKE W, QUIRYNEN M: Tongue coating: related factors. *J Clin Periodontol* 40: 180–185 (2013)
- YOKOYAMA S, OHNUKI M, SHINADA K, UENO M, WRIGHT F A, KAWAGUCHI Y: Oral malodor and related factors in Japanese senior high school students. *J Sch Health* 80: 346–352 (2010)
- ZÜRCHER A, FILIPPI A: Findings, diagnoses and results of a halitosis clinic over a seven year period. *Schweiz Monatsschr Zahnmed* 122: 205–216 (2012)