ORIGINAL ARTICLE

Oral malodour and its association with age and sex in a general population in Brazil*

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AIM: To assess the prevalence of persistent oral malodour in a general population in Rio de Janeiro and to find out whether sex and age are risk factors for this condition.

METHODS: This was a cross-sectional survey in which university students (informants) were interviewed regarding the prevalence of persistent oral malodour in their households. To estimate the effects of sex and age logistic regression models with and without random effects for the informant were applied.

RESULTS: The prevalence of persistent oral malodour was 15% (95% confidence interval: 11–19). The risk of persistent malodour was nearly three times higher in men than in women, regardless of age. The risk was slightly more than three times higher in people over 20 years of age compared with those aged 20 years or under, controlling for sex.

CONCLUSIONS: Oral malodour is common in Rio de Janeiro, more prevalent in men and in those over 20 years of age, in both sexes.

CLINICAL RELEVANCE OF THE FINDINGS: Freedom from disabling oral malodour is an outcome indicator of social well-being. Health professionals in general, and dentists in particular, should be trained to appropriately manage and treat people who suffer from persistent oral malodour.
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Introduction

There has been limited research into the prevalence of oral malodour (Miyazaki *et al*, 1995, 1996; Loesche *et al*, 1996; Yaegaki *et al*, 1996; Lee *et al*, 1999; Soder *et al*, 2000; Loesche and Kazor, 2002; Iwanicka-Grzegorek *et al*, 2005; Knaan *et al*, 2005; Liu *et al*, 2005). These epidemiological studies suggested that the prevalence of oral malodour ranges from 2% to 49%. The inconsistent results are probably due to diverse methods and criteria to measure and to define oral malodour employed in different studies. In addition, rarely the samples surveyed, represented populations in general (Miyazaki *et al*, 1995; Soder *et al*, 2000; Loesche and Kazor, 2002; Iwanicka-Grzegorek *et al*, 2005; Knaan *et al*, 2005; Liu *et al*, 2005).

The risks in men and women and at different ages were virtually unreported. The prevalence in men seems to be slightly higher than in women, though statistically significant differences were not observed. Small statistically significant differences were observed between younger and older age groups; lower prevalence among those aged 15–34 years than among those aged 35–64 years (Miyazaki *et al*, 1995). The prevalence of oral malodour in Brazil has not been documented.

Organoleptic scores, or the use of one's nose to smell and rank the intensity of the odours emanating from the mouth, is the gold standard for the measurement of oral malodour (Loesche and Kazor, 2002). Organoleptic scales are used widely in breath research. The contribution of different volatile compounds and volatile sulphur compounds (VSCs) to an overall odour, detected in organoleptic assessments, depend on odour threshold, odour power and gas concentration (Greenman *et al*, 2004). Two of the most influential halitosis researchers maintain that the use of one's nose to smell the odours emanating from other people's mouths is the gold standard for the measurement of oral malodour, as it reflects the presence of an objectionable odour as detected by an observer. The human nose remains the gold standard for measuring halitosis (Rosenberg and McCulloch, 1992; Loesche and Kazor, 2002).

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Considering that there usually is a consensus in social circles, about who does and does not have oral malodour, may be there is no need to train human judges to detect and measure oral malodour (Rosenberg and McCulloch, 1992). Moreover, it is not clear whether training increases the ability of a person to measure oral malodour (Rosenberg and McCulloch, 1992). The self-reporting of oral malodour is unreliable (Rosenberg and McCulloch, 1992; Loesche and Kazor, 2002). It is difficult for someone to know if he or she has bad breath without being told so. And giving the embarrassment involved, being told is unlikely (Rosenberg, 2002). Third party assessment by a close personal friend or relative was associated with VSCs concentration in the mouth air, which are the main direct precursors of oral malodour, and with organoleptic professional assessment by the dentist and trained odour judges (Rosenberg et al, 1991, 1995; Nadanovsky et al, 1999; Greenman et al, 2004).

The aim of this study was to assess the prevalence of persistent oral malodour in a general population in Rio de Janeiro and to find out whether sex and age are risk factors for this condition.

Methods

This was a cross-sectional survey in which students of the University of the State of Rio de Janeiro were interviewed regarding the prevalence of persistent oral malodour in their households. They were asked to assess the oral odour of people who lived with them, through the following question: 'Of the people who live in your household, how many would you say, usually have bad breath (excluding you)?' L.M.B.C. conducted all interviews, by telephone, between May and November 1999. Each interview lasted approximately 7 min. From now on in the manuscript, the students will be referred to as informants.

Sampling

For an expected prevalence of 10 ± 5% of people with persistent oral malodour, a sample of 144 subjects would be enough. Assuming an average of three people residing with each informant (E. Faerstein, D. Chor, C. de Souza Lopes, G. L. Werneck, unpublished data from the Pró-Saúde study at the University of the State of Rio de Janeiro), we needed to interview 48 informants. However, in order to study the association with age and sex, a simple random sample of 200 informants was selected from the list of 19 613 students enrolled at the university. This list was provided to us by the university administration, in an electronic format, from which we obtained each student's unique enrolment and telephone number, name, address and faculty. The randomization was achieved using the random selection command of the computer programme SPSS-PC (SPSS Inc., Chicago, IL, USA). Thereafter, we tried to contact all the selected informants, either by telephone or by telegram. Those whose telephone numbers and addresses were missing, incomplete or wrong were excluded. According to the university administration these cases represented mainly unreported change of address. Those informants acquainted with the interviewer were also excluded.

The study was approved by the Ethics Committee of the University of the State of Rio de Janeiro.

Data analysis

The percentage of people with persistent oral malodour was described for the whole population and according to sex and age, with the 95% confidence intervals. Adjusted odds ratios for sex and age were calculated using logistic regression with and without random effects. Data analysis was carried out using the software SPSS-PC version 8.0 for ordinary logistic regression and MLwiN 2.0 (University of Bristol Centre for Multilevel Modelling, Bristol, UK) for logistic regression with random effects. The latter is useful to adjust the standard errors for the clustering of individuals within households (informants). To deal with the clustering a logistic regression model with a random effect for the household (informant) was fitted. Such a model is also referred to in the literature as a multilevel logistic regression model with individuals nested within informants. The full model specification consisted of a random intercept, fixed effects for sex and age group at the individual level and a fixed effect for sex at the informant level. Later on the same model with the addition of a cross-level interaction between individual and informant sexes was examined. The method of Penalized Quasi Likelihood, second order, was adopted throughout the analysis.

Results

The informants (university students)

Of the 200 selected informants 54 could not be contacted due to missing, incomplete or wrong telephone and address. Twenty-three had the correct telephone number, as confirmed by the person in the household who answered the phone, but on two attempts they were out. Three informants were acquainted with the interviewer; two refused to be interviewed. In total, 118 of 146 informants contacted were interviewed (81% response rate, not considering the 54 with missing, incomplete or wrong telephone and address).

Sixty-five per cent of the informants interviewed were females and 69% were aged between 20 and 29 years. Only one of 118 informants lived alone. On average, each informant lived with 2.9 persons in their households; 78% lived with two, three or four persons (21%, 32% and 25%, respectively). The informants formed a diverse group of people, regarding their areas of activity and academic interests. Among the 118 informers there were only two dental and seven medical students.

The sample

The sample consisted of 344 individuals aged 1–87 years. The mean age was 39 (s.d. 18) and the median 45.51% were females (Table 1).

The prevalence of persistent oral malodour in the whole sample was 15% (95% CI: 11–19). In women it

Table 1 The study population, assessed regarding the prevalence of persistent oral malodour, Rio de Janeiro, Brazil

	Number	%
Sex		
Women	176	51
Men	167	49
Missing	1	0
Total	344	100
Age (years)		
≤20	71	21
21–40	91	26
41–60	154	45
≥60	28	8
Missing	1	0
Total	344	100

Table 2 The prevalence of persistent oral malodour, according to sex and age, in a general population, Rio de Janeiro, Brazil

	Persistent oral malodour (%)	95% CI
Sex		
Women	9	5–13
Men	21	15–27
Age (years)		
≤20	7	1–13
>20	17	13–21
Total	15	11–19

Table 3 Logistic regression analysis of the association between persistent oral malodour with sex and age, in a general population, Rio de Janeiro, Brazil

	Adjusted [a] odds ratio	95% CI
Sex	2.9	1.5–5.4
Age[b]	3.3	1.1–9.6

[a]Adjusted for sex and age.
[b]Two categories: ≤20 and >20.

Table 4 Estimated prevalence and 95% confidence intervals for the effects of sex of the informant and of the individual, for individuals under 21 years old and 21 or above

Sex of the informant. Sex of the individual [a]	Less than 21 years old	21 years old or older
Man. Male	5.91 (2.53–13.20)	19.39 (9.03–36.81)
Woman. Male	4.88 (2.63–8.86)	16.41 (9.38–27.14)
Man. Female	0.27 (0.02–3.21)	1.01 (0.08–11.28)
Woman. Female	2.65 (1.24–5.59)	9.44 (4.57–18.48)

[a]Multilevel logistic regression, with individuals nested within informants.
Man. Male = man informant and male individual; Woman. Male = woman informant and male individual; Man. Female = man informant and female individual; Woman. Female = woman informant and female individual.

was 9% and in men 21%. Oral malodour according to age was analysed in two ways: nine age categories (0–10 years of age, 11–20, 21–30, …, 81–90) and four age categories (0–20 years of age, 21–40…). From these analyses we found that from 20 years of age onwards the prevalence of oral malodour remained relatively stable. For example, the prevalence between 0 and 20 years of age was 7%, 15% between 21 and 40 years, 18% between 41 and 60 years and 14% in those over 60 years. For this reason in further analyses we transformed age into a dichotomous variable, from 0 to 20 and over 20 years of age (Table 2). In the whole sample, only 15 people under 10 years and seven people over 70 years were assessed, therefore, the prevalence of persistent oral malodour in these age groups could not be ascertained in our study.

Ordinary logistic regression results showed that the risk of persistent malodour was nearly three times higher in men than in women, regardless of age. In addition, we are 95% sure that the risk of persistent malodour in men compared with women lies in the range 1.5–5.4. The risk is slightly more than three times higher in people over 20 years of age compared with those aged 20 years or under, controlling for sex. The 95% confidence intervals are rather wide; the risk in those over 20 years of age just excludes the value 1.0 that indicates no increased risk. The model classified correctly a total of 85% of the sample (Table 3).

Multilevel logistic regression results confirmed those from ordinary logistic regression but also revealed a sex difference in reporting of female individuals. The results are shown by means of prevalence (Table 4). To allow

distinguishing the effects, sex of the individual was categorized as male or female whereas sex of the informant as man and woman. Thus the prevalence of the outcome for males who were evaluated by male informants is listed in Table 4 in the first row; if the informant was a female the prevalence is shown in the second row, etc.

Furthermore under the logistic model with a random effect for the informant, fixed effects for age and sex of the individual and fixed effects for sex of the informant and the interaction terms of sexes, four hypothesis tests were carried out with the following null hypotheses and resulting P-values: (i) females are reported positive (malodour present) equally by men and women ($P > 0.10$); (ii) males are reported positive equally by men and women ($P > 0.70$); men report equally that males and females are positive ($P < 0.05$); and (iv) women report equally that males and females are positive ($P > 0.15$).

Discussion

We found that, in a general population in Rio de Janeiro, 15% presented persistent oral malodour. This result is not trivial; 24% of the informants reported that they had trouble enjoying the company of the family member with halitosis, and 62% said that they were affected in some way by their relative's breath problem, but 24% did not tell the sufferer that the problem existed. From anecdotal accounts, nearly half of the dentists who attended the American Dental Association annual conference in 1995 reported seeing six or more

patients weekly with unpleasant breath (Meskin, 1996), and in Britain, it is believed that up to a quarter of adults may suffer regularly from bad breath (British Dental Association, 1999). Previous studies found that the prevalence of oral malodour ranges from 2% to 49% (Miyazaki et al, 1995; Soder et al, 2000; Loesche and Kazor, 2002; Loesche and Kazor, 2002; Iwanicka-Grzegorek et al, 2005; Knaan et al, 2005; Liu et al, 2005). Our result is within this range. It is interesting that despite the variety of methods employed to measure oral malodour in different studies, nearly all of them suggest that approximately one in four people suffer from persistent oral malodour. The exception was the much lower prevalence found in a Swedish study, 2%, but this discrepancy can be explained by the fact that they used a definition of oral malodour that included only extreme cases – 'strong evil-smelling odour from the mouth of the patient, which had an effect on the examiner and made the oral examination excruciating' (Loesche and Kazor, 2002). In our study, we found a somewhat lower prevalence than usually reported. It is difficult to explain the reason for that, but it may be related to the method of measurement applied in our study (direct information from a family member), to the definition of oral malodour (only habitual oral malodour), and to the level of education of the subjects in our sample (family members of university students households); it is possible that the university students' families have higher level of education compared with general populations. And higher level of education is usually associated with better oral hygiene. Obtaining information directly from a close person and asking them not to consider the sporadic oral malodour that everybody experiences, especially when waking up in early morning, might partially explain why we found a lower prevalence of oral malodour than it is usually reported.

We also found that while the prevalence of persistent oral malodour in men was 21%, in women it was 9%, and in those over 20 years of age it was 17% while in those under 20 it was 7%. The risks according to sex and age were independent of each other, i.e. controlling for age, men were three times as likely to present persistent oral malodour compared with women, and among either men or women, those over 20 years of age were three times as likely to present persistent oral malodour compared with those under 20 years of age. Our finding, regarding age as a risk factor for persistent oral malodour, is not applicable to people under the age of 10 and for those over 70, as the number of people in these age groups, in our sample, was too small. In a cross-sectional survey of a general population aged 15–64 in Japan, VSC increased with age. In that same survey, men showed slightly higher VSC than women in some age groups, but in most comparisons between the sexes, no statistically significant differences were observed. In another cross-sectional study, with patients in a halitosis clinic in Israel, on average men obtained higher oral malodour organoleptic scores from a professional judge than women. Both studies, the one in Japan with a general population and the one in Israel

with a patient population, found results, which were in the same direction as ours. However, neither of them carried out specific analyses aiming at assessing sex or age as independent risk factors (Miyazaki et al, 1995; Rosenberg and Leib, 1995). Therefore, it is not possible to compare the association of oral malodour with sex and age that we found in Rio de Janeiro with those reported in Japan and Israel. In China, age was found not to be a risk factor for oral malodour (Liu et al, 2005).

The method of measuring oral malodour in our study received careful consideration, and was chosen, because of validity concerns. We were interested in the real life experience of oral malodour. Real life experience must reflect the detection of objectionable odour by common people, not by an expert. Also, it is important to detect people who present malodour constantly, not only at a one off examination in a research setting. In addition, although there usually is a consensus in social circles, about who does and does not have oral malodour (Rosenberg and McCulloch, 1992), using only one or two assessors might not reflect this social consensus. Using a large number of assessors was a way of obtaining information, which would, more likely, reflect a social consensus regarding the presence of bad breath. Generally, in our study, reporting or being reported of persistent oral malodour did not differ significantly according to the sex of the informant. The only exception was the reporting of female individuals. Significantly fewer women were reported as presenting persistent oral malodour when the informant was a man; the hypothesis that men report equally that males and females present oral malodour, was refuted. Finally, we chose to select the assessors from a telephone register of university students because we wanted to make sure that the number of non-respondents would be kept to a minimum, and that we would be able to ascertain the reasons for non-responses. We could think of no other better telephone register in Rio de Janeiro with such characteristics, available to us, which could provide access to a general population.

Although we were unable to contact 54 of the selected students, bias was probably not introduced, as these students could not be contacted simply because of change of address. We left a message to 23 but they did not return the call. As they did not know the reason for us calling them, it is not likely that oral malodour was less or more prevalent in their households, compared with the respondents. Three students, who were acquainted with the interviewer, were excluded because they might have felt embarrassed to answer the questions truthfully. Only two students refused to be interviewed. Considering the reasons for non-response, with only two known refusals, a response rate of 81% seems reassuring.

Conclusion

Oral malodour is common in Rio de Janeiro and may have substantial social impacts on the sufferers and their families. Freedom from disabling oral malodour is an

outcome indicator of social well-being. Health professionals in general, and dentists in particular, should be trained to appropriately manage and treat people who suffer from persistent oral malodour. Future studies should seek to confirm or reject our findings related to age and sex, and, if confirmed, explore why men and those aged 20 years of age and over, have higher risk of suffering from persistent oral malodour. Oral cleanliness and periodontal condition might explain, in part, these increased risks, as well as the composition of the bacterial flora of the tongue (Loesche and Kazor, 2002).

Acknowledgements

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