

More to learn about: periodontitis-related knowledge and its relationship with periodontal health behaviour

Renate Deinzer¹, Wolfgang Micheelis², Nicole Granrath¹, Thomas Hoffmann³

¹Institute of Medical Psychology, University of Giessen, Giessen, Germany; ²Institute of German Dentists (IDZ), Cologne, Germany; ³Department of Periodontology, University of Dresden, Dresden, Germany

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Abstract

Aim: To assess periodontitis-related knowledge and its relation to oral health behaviour on a community level and to identify target groups and major topics for health education interventions.

Material and Methods: By means of a multistratified, stochastic telephone survey, 1001 interviews with Germans older than 14 years were carried out. Participants answered questions on the definition, aetiology, and risk factors of periodontal disease and on the risks associated with and measures to prevent them. They also reported on their current oral health behaviour.

Results: Severe knowledge deficits were found with respect to all topics. No consistent relationships with age or education were found, although less educated and very young and old people tended to show the greatest deficits. Knowledge of preventive measures was most strongly related to current oral health behaviour.

Conclusions: Health education on periodontal diseases must be improved on a community level, although schoolchildren, older citizens and the less educated are the groups most in need. Interventions should focus on preventive measures.

Key words: health behaviour; health-related knowledge; patient education; periodontology; prevention; risk factors

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Periodontitis is a chronic inflammatory disease and, after caries, is the major cause of tooth loss in adult populations (Albandar 2005). Generally, a high prevalence of periodontitis among adults, with disparities to a notable extent, is reported (Oliver et al. 1998, Sheiham & Netuveli 2002, Gera 2004, Bourgeois et al. 2007). While in a few studies, a decline in the prevalence of periodontitis was shown (Dye et al. 2007,

Hugoson & Norderyd 2008, Hugoson et al. 2008), a slight increase, especially in the German population, could be observed (Micheelis et al. 2008), possibly due to an increased number of retained teeth. In this representative German survey, >20% of the middle aged (35–44) and >39% of the elderly (65–74) showed periodontal pockets of 6 mm and more (Hoffmann 2006a, b). A few years ago, the respective figures were 14% (35–44) and 24% (65–74; Reich 1999a, b). Thus, future tooth loss – in parallel with the decline in caries (Micheelis & Schiffner 2006) – could be increasingly attributed to periodontitis (Holtfreter et al. 2009). This puts the need for periodontitis prevention into a new socioeconomic perspective.

Even though well-controlled studies assessing the effects of patients' oral health behaviour on the incidence and progression of periodontal disease are missing (Hujuel et al. 2005), a considerable number of studies suggest an important role of oral hygiene in periodontal health. In their classical investigations, Axelsson & Lindhe (1981), Lindhe & Nyman (1984), and Axelsson et al. (1991) showed that thoroughly professional plaque removal and excellent supportive care, together with optimal individual hygiene procedures, resulted in an improvement of periodontitis and stable periodontal health (under highly standardized conditions). This is supported by the findings of Hirschfeld & Wasserman (1978),

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McFall (1982), and König et al. (2001), who found that poor oral hygiene and non-compliance go along with progression of periodontitis and tooth loss. Furthermore, a recently published longitudinal study over >20 years identified calculus and persistent gingivitis as important predictors for future periodontal attachment loss and tooth loss (Lang et al. 2009, Schätzle et al. 2009). There is no doubt that neglecting oral hygiene results in calculus and gingival inflammation (Löe et al. 1965). We therefore find it reasonable to consider patients' oral hygiene as one preventive measure against periodontal disease. We do, however, agree that further well-controlled research is needed to support this notion.

A high prevalence of plaque, gingivitis, and periodontitis indicates that oral hygiene behaviour should be improved in Germany on a community basis. Fewer than 50% of German middle-aged adults and fewer than 25% of the elderly report flossing their teeth at least sometimes. Not surprisingly, the prevalence of periodontitis is significantly lower in those reporting flossing (Deinzer et al. 2008).

A pre-condition to improving health behaviour is sufficient knowledge of the behaviour itself and why it should be improved (Becker 1974, Ajzen 1991, Prochaska & Velicer 1997, Hugoson et al. 2007, Jones et al. 2007). Oral health education would thus be an important step. Before starting such educational activities on a community level, one should, however, determine what is already known, how different age, gender, and educational groups differ, and which knowledge is most strongly related to oral health behaviour. The present study focuses on these questions. In a representative telephone survey, 1001 Germans aged 14–89 were asked about their periodontitis-related knowledge and their oral health practices.

Methods

Overall methods and questionnaire

The aim of the study was to assess periodontitis-related knowledge in the German population. The main topics were the definition of periodontitis, its risk factors, risks for other diseases associated with periodontitis, and measures to prevent periodontal diseases. The study was designed as a telephone survey. Thus, we were able to assess both the active knowledge reflected in

spontaneous answers of participants (open questions), and subsequently, the passive knowledge reflected by their ability to give the correct alternative from a number of distractors (multiple choice, prespecified answers). The questions referred to the topics covered in the current gold standard of German health education brochures on periodontitis, the patient brochure of the German Society for Periodontology (Deutsche Gesellschaft für Parodontologie 2008). Before this community survey, the suitability of questions with respect to their clarity and comprehensibility was tested in several studies, where they were given in the form of a written questionnaire. In a student sample, the re-test reliability of repeated assessments after 4 weeks was $r_{tt} = 0.60$ and the overall score correlated moderately ($\rho = 0.24$; $p < 0.05$) with clinically assessed oral hygiene (see Granrath 2007). Additionally, participants were asked which oral hygiene devices they used and how often.

When subjects were asked to participate in the study, they were only informed of the topic (oral health). During the interview, technical terms like "periodontitis" were explained as necessary by using other, better-known terms (e.g. the German "Parodontose," which is an outdated term, although used more often than the correct German "Parodontitis" by laypersons and in advertisements).

Interviewers were trained for the interview and in particular were taught to present the questions in a standardized manner.

Sampling method

The study refers to the German-speaking German population older than 14 years, living in private homes connected to the fixed telephone network. The number of such private homes by far exceeds 90%, both in eastern and in western Germany. The sampling model was based on all registered fixed network telephone numbers in Germany in 2006; an additional procedure (Gabler-Häder-Procedure; Häder & Gabler 1998) allowed contact with non-registered telephone numbers as well. The survey was based on the Infratest Telephone Master Sample, a multistratified sample with area sampling (geographic location of the population units in Germany) as a first step, a consecutive (second step), Random Digit Dialling,

and finally a stochastic selection of the person to be interviewed within a private home.

Altogether, 2266 telephone contacts were made. After deletion of unsuitable contacts (fax numbers, companies, etc.), 1963 contacts remained, of which 1001 could be used for the interviews. The demographic structure of this sample equates to the German population with respect to gender, age, education, and geographic region very well, thereby allowing us to abstain from statistical weighting of data (see Deinzer et al. 2008). Furthermore, a recent study on the telephone survey methodology in Germany indicated that non-responding is due to current states (e.g. recent experiences with surveys) rather than stable traits (e.g. personality, sociodemographic factors) of the participants (Schnauber & Daschmann 2008). This reduces the chance of a systematic bias in our results due to non-responding.

Statistical data analysis

SPSS 15.0 (SPSS Inc.) is used for all statistical analyses. On a descriptive basis, we first analysed the percentage of correct answers for each question (these data have already been published in a German publication, Deinzer et al. 2008). Questions correctly answered by <80% of the sample were considered to be indicative of a knowledge deficit in the population. For these questions, we then analysed group differences with respect to gender, age, and education. The following educational groups were analysed according to the German school system, which comprises three levels of school education: pupils (participants still attending school), participants with no more than primary school education (lowest level), participants with secondary school education (medium level), and those with a university entrance diploma (third level). We further analysed which knowledge topic shows the strongest relationship with oral health behaviour as measured by the daily use of interdental brushes, dental floss, or both. For statistical analyses, we computed χ^2 statistics. To obtain an estimate of the overall effect size of the three factors gender, education, and age, as well as of their interactions, we additionally computed logistic regressions with all possible twofold interactions terms and the threefold interaction. All variables and interaction terms are entered together.

Nagelkerkes approximates for R^2 are computed as indicators of overall effect size. No α -error correction is computed due to the pilot character and descriptive nature of our presentation; thereby the α -error probabilities given should be regarded as indicators of effect size rather than validation of any inferential statistics.

Results

Sample description

Table 1 shows the number of participants in the respective age, gender, and educational groups. The demographic structure of this sample with respect to gender, age, education, and geographical region equates with the German population very well (for further details, see Deinzer et al. 2008).

Knowledge of the definition of periodontitis

In order to assess the active knowledge of the definition of periodontitis, participants were asked: "What is periodontitis?" None of the participants gave a correct answer, 15.6% could not give any answer at all, while 55.2% at least realized there was some association with diseases of the gum when they defined periodontitis as gingival recessions (29.8%), gingivitis (19.9%), disease of the gum (10.6%), or bleeding gums (4.6%), respectively.

When participants were presented with five alternative answers, one of which was correct, 11% gave the correct answer ("an inflammation of the periodontium already affecting the periodontal bone"), with no difference between men (10.4%) and women (11.5%; group difference: $\chi^2 = 0.285$, $df = 1$, $p = 0.594$), while the others chose one of the four incorrect distractors (exposed cervical margin of tooth that became especially pain sensitive; an inflammation of the gum; a loss of periodontal bone induced by age or genetics; and a painful inflammation of the gum with excrescences). No group differences were observed (see Table 2).

Knowledge of risks associated with periodontitis

To assess their active knowledge of the risks associated with periodontal disease, we put the following question to the participants: "People suffering from periodontitis do have an increased risk

Table 1. Sample characteristics: number of participants in the respective groups

| | Education | | | | | Sum |
|--------------|-----------|----------------|------------------|-----------------------------|-------|------|
| | pupil | primary school | secondary school | university entrance diploma | pupil | |
| Men | | | | | | |
| Age group | < 19 | 26 | 5 | 4 | 6 | 41 |
| | 20–29 | 0 | 10 | 26 | 23 | 59 |
| | 30–39 | 0 | 40 | 30 | 18 | 88 |
| | 40–49 | 0 | 31 | 19 | 34 | 84 |
| | 50–59 | 0 | 28 | 18 | 0 | 46 |
| | 60–69 | 0 | 55 | 19 | 8 | 82 |
| | > 70 | 0 | 39 | 11 | 29 | 79 |
| Sum | | 26 | 208 | 127 | 118 | 479 |
| Women | | | | | | |
| Age group | < 19 | 23 | 1 | 6 | 4 | 34 |
| | 20–29 | 3 | 15 | 29 | 18 | 65 |
| | 30–39 | 0 | 30 | 40 | 4 | 74 |
| | 40–49 | 0 | 35 | 53 | 10 | 98 |
| | 50–59 | 0 | 49 | 34 | 17 | 100 |
| | 60–69 | 0 | 50 | 27 | 3 | 80 |
| | > 70 | 0 | 43 | 15 | 13 | 71 |
| Sum | | 26 | 223 | 204 | 69 | 522 |
| Sum | | 52 | 431 | 331 | 187 | 1001 |

Table 2. Passive knowledge of the definition of periodontitis: percentage of the correct answer selected from five alternatives*

| Age group | | | | | | | χ^2 (df) | <i>p</i> |
|-----------|----------------|------------------|-----------------------------|-------|-------|-----------|---------------|----------|
| < 19 | 20–29 | 30–39 | 40–49 | 50–59 | 60–69 | > 70 | | |
| 8.0% | 8.9% | 14.2% | 13.7% | 8.9% | 9.9% | 10.7% | 5.233 (6) | 0.514 |
| Education | | | | | | | χ^2 (df) | <i>p</i> |
| pupil | primary school | secondary school | university entrance diploma | | | | | |
| 11.5% | 13.2% | 8.5% | 10.2% | | | 4.516 (3) | 0.211 | |

*No significant gender differences observed (see text).

for other disorders; do you know any of these disorders?" The majority of participants (65.7%) could not give an answer. The answer given most often was myocardial infarction (8.2%), with a significant difference between men (5.8%) and women (10.3%; $\chi^2 = 6.724$, $df = 1$, $p = 0.010$). No further group differences were found concerning this answer (see Table 3).

Participants were then asked, "In the following, I will mention several diseases. Please assess whether patients with periodontitis have an increased risk for these diseases." They were presented with 12 alternatives, five of which were considered to be correct (tooth loss, persistent damage of the alveolar bone, myocardial infarction, diabetes, preterm birth). "Tooth loss"

(94.1%) and "persistent damage of the alveolar bone" (83.4%) were chosen by > 80% of the participants. Myocardial infarction was indicated to be correct by 27.1% male and 31.8% female participants, which revealed a tentatively significant difference ($\chi^2 = 2.606$, $df = 1$, $p = 0.106$). No gender differences were found for the answers diabetes and preterm birth (all $p > 0.239$). Table 4 shows group differences in these variables with respect to age and education.

Knowledge of risk factors for periodontitis

In order to assess their knowledge of risk factors for periodontitis, the term "risk factor" was initially explained to the participants ("risk factors are factors

Table 3. Active knowledge of the risks associated with periodontitis: percentage of participants mentioning myocardial infarction

| | Age group | | | | | | | χ^2 (df) | <i>p</i> |
|-------|-----------|-----------|-----------|-----------|-----------|-----------|---------|---------------|----------|
| | <19 (%) | 20–29 (%) | 30–39 (%) | 40–49 (%) | 50–59 (%) | 60–69 (%) | >70 (%) | | |
| Women | 5.9 | 7.7 | 10.8 | 8.2 | 16.0 | 11.3 | 8.5 | 5.537 (6) | 0.477 |
| Men | 0.0 | 5.1 | 10.2 | 6.0 | 8.7 | 4.9 | 3.8 | 7.100 (6) | 0.312 |

| | Education | | | | χ^2 (df) | <i>p</i> |
|-------|-----------|--------------------|----------------------|---------------------------------|---------------|----------|
| | pupil (%) | primary school (%) | secondary school (%) | university entrance diploma (%) | | |
| Women | 3.8 | 12.6 | 9.8 | 7.2 | 3.138 (3) | 0.371 |
| Men | 0.0 | 4.3 | 7.9 | 7.6 | 4.116 (3) | 0.249 |

Table 4. Passive knowledge of the risks associated with periodontitis: percentage of participants indicating myocardial infarction, diabetes, and preterm birth*

| | Age group | | | | | | | χ^2 (df) | <i>p</i> |
|-----------------------|-----------|-----------|-----------|-----------|-----------|-----------|---------|---------------|--------------|
| | <19 (%) | 20–29 (%) | 30–39 (%) | 40–49 (%) | 50–59 (%) | 60–69 (%) | >70 (%) | | |
| Myocardial infarction | 17.3 | 22.6 | 35.8 | 29.1 | 36.3 | 31.5 | 26.7 | 15.408 (6) | 0.017 |
| Diabetes | 8.0 | 15.3 | 16.0 | 14.3 | 17.1 | 20.4 | 21.3 | 8.971 (6) | 0.175 |
| Preterm birth | 5.3 | 12.1 | 7.4 | 7.7 | 8.2 | 6.8 | 4.7 | 6.264 (6) | 0.394 |

| | Education | | | | χ^2 (df) | <i>p</i> |
|-----------------------|-----------|--------------------|----------------------|---------------------------------|---------------|--------------|
| | pupil (%) | primary school (%) | secondary school (%) | university entrance diploma (%) | | |
| Myocardial infarction | 13.5 | 31.8 | 28.7 | 30.5 | 7.690 (3) | 0.053 |
| Diabetes | 1.9 | 19.3 | 16.3 | 15.5 | 10.423 (3) | 0.015 |
| Preterm birth | 0.0 | 8.1 | 7.9 | 7.5 | 4.520 (3) | 0.211 |

*No significant gender differences observed (see text).

Value in bold italic signifies the results within a prespecified significance level of $p \leq 0.05$.

linked to a faster emergence or a more severe course of periodontitis”). Active knowledge of risk factors was then assessed by asking: “Do you know any risk factors for periodontal disease?” While 57.7% of participants could not provide any answer, 31.8% mentioned at least one factor associated with oral hygiene [poor/faulty tooth brushing (20%), poor/faulty/absent oral hygiene (14.5%), plaque bacteria (1.3%), and dental calculus (1.6%)], with a tentatively significant difference between men (29.0%) and women (34.3%; $\chi^2 = 3.203$, $df = 1$, $p = 0.073$). Significant differences for women and men were found between different age and education groups (see Table 5).

When passive knowledge of the same topic was determined (“please assess which of the following factors are risk factors for periodontitis”), >80% indicated gingivitis (90.9%), dental calculus (82.1%), and plaque bacteria (80.1%) to be risk factors. From the remaining eight alternative answers, those considered to be correct were chosen by 75.8% (nicotine consumption), 34.8% (stress), and 34.6% (diabetes), respectively. No gender

differences were found in these ratings (all $p > 0.381$), although significant differences with respect to age and education groups were observed (see Table 6).

Knowledge of preventive measures for periodontitis

To further assess their knowledge of periodontitis, participants were presented with a number of statements and were asked to decide whether these were right or wrong. More than 80% of participants knew that not just older persons are susceptible to periodontitis (90.8%) and that untreated periodontitis will ultimately cause tooth loss (95.6%). Table 7a shows the overall percentage of participants giving the correct answers to the remaining statements, together with gender differences. Further group analyses are given in Table 7b.

Participants were also asked which devices they thought were necessary to maintain good oral health. They were therefore presented with a list of 12 devices and asked to indicate which of them were absolutely necessary [“Industry provides several devices for

oral hygiene. Which of them are absolutely necessary to maintain good oral health? (i.e. to prevent caries and periodontitis)”). More than 80% indicated that a toothbrush (98.4%) and toothpaste (93.4%) are absolutely necessary. Additionally, >80% indicated at least one device for interdental hygiene (dental floss, interdental brushes) to be absolutely necessary (84.2%). More than 90% (90.5%) indicated that at least one additional device (antibacterial mouth rinse, oral irrigator, tongue cleaner, powered toothbrush, chewing gum, tooth picks, gum stimulators, tooth whitener) was not considered to be absolutely necessary from a dental point of view; 27.2% indicated three or more additional devices from the list.

When asked how often these devices should be used (open question without frequency specifications), 98% indicated toothbrush and 93.1% indicated toothpaste should be used at least once daily. With regard to interdental hygiene (floss or interdental brushes), 71.3% indicated that these should be used at least once daily, with significant differences between men (67.6%) and women

(74.7%; $\chi^2 = 6.215$, $df = 1$, $p = 0.013$). No further group differences were observed (see Table 8).

Relationship of knowledge with regular use of interdental devices

To assess which knowledge topic is most strongly related to daily use of interdental

devices (dental floss, interdental brushes, or both), we compared participants reporting daily use of interdental devices (38.7%) with those reporting less frequent use (21.2%), or none at all (40.1%). Considerable group differences were found with respect to this measure, with women (45.8%) reporting daily use more often than men (30.9%; $\chi^2 = 23.346$, $df = 1$, $p < 0.001$), the least educated

reporting less use than all others, and older women reporting daily use less frequently than younger ones (see Table 9).

For all the knowledge deficits identified in our sample (<80% correct answers), the only meaningful ($p \leq 0.05$) differences between daily users of interdental devices and non-daily or non-users were found for active knowledge of hygiene as a risk factor, chewing surfaces

Table 5. Active knowledge of the risks factors of periodontitis: percentage of participants mentioning oral hygiene-related factors

| | Age group | | | | | | | χ^2 (df) | <i>p</i> |
|-------|-----------|--------------------|----------------------|---------------------------------|-----------|-----------|---------|---------------|------------------|
| | <19 (%) | 20–29 (%) | 30–39 (%) | 40–49 (%) | 50–59 (%) | 60–69 (%) | >70 (%) | | |
| Women | 35.3 | 49.2 | 39.2 | 42.9 | 31.0 | 22.5 | 21.1 | 21.311 (6) | 0.002 |
| Men | 22.0 | 39.0 | 38.6 | 33.3 | 28.3 | 22.0 | 17.7% | 15.445 (6) | 0.017 |
| | Education | | | | | | | χ^2 (df) | <i>p</i> |
| | pupil (%) | primary school (%) | secondary school (%) | university entrance diploma (%) | | | | | |
| Women | 38.5 | 20.2 | 44.6 | 47.8 | | | | 35.156 (3) | <0.001 |
| Men | 23.1 | 21.6 | 29.9 | 42.4 | | | | 16.218 (3) | 0.001 |

Value in bold italic signifies the results within a prespecified significance level of $p \leq 0.05$.

Table 6. Passive knowledge of the risk factors for periodontitis: percentage of participants indicating nicotine consumption, stress, and diabetes as risk factors*

| | Age group | | | | | | | χ^2 (df) | <i>p</i> |
|----------------------|-----------|--------------------|----------------------|---------------------------------|-----------|-----------|---------|---------------|------------------|
| | <19 (%) | 20–29 (%) | 30–39 (%) | 40–49 (%) | 50–59 (%) | 60–69 (%) | >70 (%) | | |
| Nicotine consumption | 82.7 | 85.5 | 77.2 | 74.2 | 71.2 | 74.7 | 70.7 | 12.624 (6) | 0.049 |
| Stress | 28.0 | 50.8 | 43.8 | 40.7 | 30.8 | 21.0 | 26.7 | 43.135 (6) | <0.001 |
| Diabetes | 14.7 | 37.1 | 41.4 | 36.3 | 39.7 | 32.7 | 30.0 | 20.365 (6) | 0.002 |
| | Education | | | | | | | χ^2 (df) | <i>p</i> |
| | pupil (%) | primary school (%) | secondary school (%) | university entrance diploma (%) | | | | | |
| Nicotine consumption | 82.7 | 74.7 | 74.6 | 78.6 | | | | 2.682 (3) | 0.443 |
| Stress | 23.1 | 32.0 | 37.2 | 40.1 | | | | 7.756 (3) | 0.051 |
| Diabetes | 5.8 | 33.2 | 38.4 | 39.0 | | | | 23.201 (3) | <0.001 |

*No significant gender differences observed (see text).

Value in bold italic signifies the results within a prespecified significance level of $p \leq 0.05$.

Table 7a. Statements related to preventive measures of periodontitis: overall percentage of male and female participants deciding correctly whether the statement was right or wrong

| Statement | Men (%) | Women (%) | All (%) | Gender difference | |
|---|---------|-----------|---------|-------------------|--------------|
| | | | | χ^2 (df = 1) | <i>p</i> |
| Statements related to oral hygiene | | | | | |
| Periodontal disease is caused by dental plaque (right) | 76.4 | 79.1 | 77.8 | 1.063 | 0.303 |
| If one manages to sustain very good oral hygiene he or she will not suffer from periodontitis (right) | 71.2 | 64.4 | 67.6 | 5.311 | 0.021 |
| One cannot avoid emergence of dental calculus (wrong) | 40.3 | 42.7 | 41.6 | 0.606 | 0.436 |
| To really get the teeth clean by daily brushing above all one has to brush them firmly (wrong) | 62.4 | 70.7 | 66.7 | 7.692 | 0.006 |
| The fewest patients manage to sustain optimal oral hygiene without the help of their dentist (right) | 74.3 | 67.2 | 70.6 | 6.036 | 0.014 |
| To avoid periodontitis, it is of particular importance to brush the chewing surfaces (wrong) | 38.4 | 39.8 | 39.2 | 0.215 | 0.643 |
| Statements related to the early diagnosis of periodontitis | | | | | |
| The most frequent oral disease in adults is caries (wrong) | 24.6 | 33.7 | 29.4 | 9.932 | 0.002 |
| In early stages one recognizes periodontitis by frequent tooth aches (wrong) | 43.2 | 37.9 | 40.5 | 2.895 | 0.089 |
| A periodontitis often remains unrecognized for years (right) | 72.0 | 71.8 | 71.9 | 0.004 | 0.948 |

Value in bold italic signifies the results within a prespecified significance level of $p \leq 0.05$.

Table 7b. Statements related to preventive measures of periodontitis: subgroup analysis of participants deciding correctly whether the statement was right or wrong*

| | Age group | | | | | | | χ^2 (df) | p |
|-------------------------------|-----------|-----------|-----------|-----------|-----------|-----------|----------|---------------|----------------|
| | < 19 (%) | 20–29 (%) | 30–39 (%) | 40–49 (%) | 50–59 (%) | 60–69 (%) | > 70 (%) | | |
| Dental plaque [†] | 69.3 | 63.7 | 77.2 | 79.7 | 83.6 | 82.7 | 81.3 | 23.948 (6) | 0.001 |
| Hygiene | | | | | | | | | |
| Women | 58.8 | 56.9 | 56.8 | 65.3 | 67.0 | 68.8 | 71.8 | 6.629 (6) | 0.357 |
| Men | 68.3 | 57.6 | 65.9 | 61.9 | 78.3 | 79.3 | 86.1 | 22.453 (6) | 0.001 |
| Calculus [†] | 64.0 | 47.6 | 34.6 | 42.3 | 39.0 | 38.3 | 38.0 | 22.589 (6) | 0.001 |
| Brush firmly | | | | | | | | | |
| Women | 79.4 | 81.5 | 87.8 | 76.5 | 73.0 | 55.0 | 45.1 | 49.310 | < 0.001 |
| Men | 53.7 | 89.8 | 75.0 | 71.4 | 52.2 | 43.9 | 48.1 | 50.034 | < 0.001 |
| Dentist | | | | | | | | | |
| Women | 70.6 | 70.8 | 70.3 | 67.3 | 67.0 | 66.3 | 60.6 | 2.325 (6) | 0.888 |
| Men | 65.9 | 83.1 | 77.3 | 78.6 | 69.6 | 78.0 | 63.3 | 11.271 (6) | 0.080 |
| Chewing surfaces [†] | 33.3 | 44.4 | 47.5 | 47.3 | 40.4 | 31.5 | 26.0 | 27.249 (6) | < 0.001 |
| Caries | | | | | | | | | |
| Women | 52.9 | 32.3 | 39.2 | 34.7 | 35.0 | 30.0 | 21.1 | 12.318 (6) | 0.055 |
| Men | 29.3 | 22.0 | 27.3 | 34.5 | 17.4 | 23.2 | 16.5 | 9.685 (6) | 0.139 |
| Tooth ache | | | | | | | | | |
| Women | 23.5 | 44.6 | 70.3 | 77.6 | 66.0 | 61.3 | 62.0 | 42.631 (6) | 0.001 |
| Men | 19.5 | 40.7 | 63.6 | 60.7 | 65.2 | 64.6 | 63.3 | 36.415 (6) | 0.001 |
| Unrecognized [†] | 53.3 | 74.2 | 71.6 | 75.8 | 73.3 | 75.3 | 70.0 | 15.862 (6) | 0.015 |

| | Education | | | | χ^2 (df) | p |
|-------------------------------|-----------|--------------------|----------------------|---------------------------------|---------------|----------------|
| | pupil (%) | primary school (%) | secondary school (%) | university entrance diploma (%) | | |
| Dental plaque [†] | 67.3 | 82.4 | 77.3 | 71.1 | 13.395 (3) | 0.004 |
| Hygiene | | | | | | |
| Women | 53.8 | 65.9 | 63.7 | 65.2 | 1.547 (3) | 0.641 |
| Men | 65.4 | 72.1 | 62.2 | 80.5 | 10.509 (3) | 0.015 |
| Calculus [†] | 71.2 | 39.4 | 43.2 | 35.3 | 22.937 (3) | < 0.001 |
| Brush firmly | | | | | | |
| Women | 76.9 | 61.9 | 78.4 | 73.9 | 15.081 (3) | 0.002 |
| Men | 53.8 | 51.4 | 68.5 | 77.1 | 24.373 (3) | < 0.001 |
| Dentist | | | | | | |
| Women | 65.4 | 68.6 | 65.7 | 68.1 | 0.478 (3) | 0.924 |
| Men | 69.2 | 76.0 | 71.7 | 75.4 | 1.195 (3) | 0.754 |
| Chewing surfaces [†] | 36.5 | 29.9 | 45.6 | 49.7 | 30.130 (3) | < 0.001 |
| Caries | | | | | | |
| Women | 53.8 | 25.6 | 38.7 | 37.7 | 14.127 (3) | 0.003 |
| Men | 30.8 | 18.3 | 26.0 | 33.1 | 9.693 (3) | 0.021 |
| Tooth ache | | | | | | |
| Women | 15.4 | 56.5 | 69.1 | 76.8 | 37.678 (3) | < 0.001 |
| Men | 26.9 | 56.3 | 55.1 | 66.1 | 13.790 (3) | 0.003 |
| Unrecognized [†] | 53.8 | 71.5 | 76.1 | 70.6 | 11.531 (3) | 0.009 |

*For full statements see Table 7a.

[†]No significant gender differences observed (see Table 7a).

Value in bold italic signifies the results within a prespecified significance level of $p \leq 0.05$.

Table 8. Active knowledge of required interdental hygiene frequency: percentage of participants indicating at least once daily

| | Age group | | | | | | | χ^2 (df) | p |
|-------|-----------|-----------|-----------|-----------|-----------|-----------|----------|---------------|-------|
| | < 19 (%) | 20–29 (%) | 30–39 (%) | 40–49 (%) | 50–59 (%) | 60–69 (%) | > 70 (%) | | |
| Women | 76.5 | 75.4 | 70.3 | 81.6 | 81.0 | 72.5 | 62.0 | 11.728 (3) | 0.068 |
| Men | 78.0 | 59.3 | 64.8 | 69.9 | 69.6 | 67.1 | 68.4 | 4.518 (3) | 0.607 |

| | Education | | | | χ^2 (df) | p |
|-------|-----------|--------------------|----------------------|---------------------------------|---------------|-------|
| | pupil (%) | primary school (%) | secondary school (%) | university entrance diploma (%) | | |
| Women | 65.4 | 73.5 | 77.9 | 72.5 | 2.669 (3) | 0.669 |
| Men | 65.4 | 65.4 | 67.7 | 71.8 | 1.464 (3) | 0.691 |

as being of minor importance for periodontal health, toothache not being an early indicator of periodontitis, firmly brushing not being important to get teeth clean, caries not being the most frequent oral disease in adults, and for frequency of interdental hygiene (see Table 10). No other meaningful differences were found (data not shown).

Multivariate analyses of the predictive value of age, gender, and education for periodontitis-related knowledge

Logistic regression analyses revealed effect sizes of $R^2 < 0.060$ for all but the following knowledge parameters: active knowledge of insufficient hygiene as a risk factor ($R^2 = 0.093$), passive knowledge of stress as a risk factor ($R^2 = 0.060$), and knowledge that firm brushing is not important to get teeth clean ($R^2 = 0.158$). Significant interaction terms ($p < 0.05$) were found for passive knowledge of stress as a risk factor (gender \times age) and passive knowledge of an increased risk of myocardial infarction (gender \times education, age \times education, gender \times age \times

education). No further significant interactions were observed.

To better understand the relationship between knowledge of periodontitis and self-reported interdental health behaviour, we computed a stepwise (forward) logistic regression with those parameters as independent variables showing a significant univariate relationship with self-reported interdental hygiene behaviour. Variables contributing significantly to prediction of self-reported daily interdental hygiene were: knowledge of the necessity of daily oral hygiene [step 1, $R^2 = 0.327$, $p(\text{change}) < 0.001$], knowledge that firm brushing is not necessary [step 2, $R^2 = 0.352$, $p(\text{change}) < 0.001$], and knowledge of caries as not being the most frequent oral disease in adults [step 3, $R^2 = 0.357$, $p(\text{change}) = 0.022$]. No other parameters contributed significantly.

Discussion

In our sample, we found knowledge deficits throughout all the topics investigated: the definition of periodontitis, risks associated with periodontitis, risk factors for periodontitis, and preventive

measures. The most severe deficits were found in active knowledge of the definition of periodontitis (0%), passive knowledge of its definition (11%), and active knowledge of risks associated with it (<10%). A number of further questions were answered correctly by <50% of our study sample. These figures indicate a considerable need for oral health education with respect to periodontitis in Germany.

Comparisons between groups revealed no consistent picture. There was neither a consistent difference between sexes nor a consistent educational gradient. With respect to age, again no consistent pattern emerged. Logistic regression analyses underlined the limited value of age, gender, education, and their interactions as predictors of periodontitis-related knowledge in Germans. Most analyses revealed small effect sizes only. Hardly any significant interactions were found between the predictors. From a descriptive point of view, and based on univariate analyses, less educated participants (primary school) knew less than more highly educated subjects about plaque as a pathogenetic

Table 9. Daily use of interdental hygiene devices: percentage of participants reporting daily use of either tooth floss or interdental brushes

| | Age group | | | | | | | χ^2 (df) | <i>p</i> |
|-------|-----------|--------------------|----------------------|---------------------------------|-----------|-----------|---------|---------------|-------------------------|
| | <19 (%) | 20–29 (%) | 30–39 (%) | 40–49 (%) | 50–59 (%) | 60–69 (%) | >70 (%) | | |
| Women | 55.9 | 41.5 | 44.6 | 54.1 | 59.0 | 37.5 | 25.4 | 25.818 (6) | <i><0.001</i> |
| Men | 43.9 | 32.2 | 34.1 | 29.8 | 32.6 | 25.6 | 25.3 | 6.066 (6) | 0.417 |
| | Education | | | | | | | χ^2 (df) | <i>p</i> |
| | pupil (%) | primary school (%) | secondary school (%) | university entrance diploma (%) | | | | | |
| Women | 50.0 | 38.1 | 53.9 | 44.9 | | | | 10.930 (3) | <i>0.012</i> |
| Men | 42.3 | 24.5 | 32.3 | 38.1 | | | | 8.558 (3) | <i>0.036</i> |

Value in bold italic signifies the results within a prespecified significance level of $p \leq 0.05$.

Table 10. Differences in knowledge between daily users ($\geq 1/\text{day}$) of interdental devices and non-daily or never users: percentage of participants giving the correct answer (only differences with a $p \leq 0.05$ are reported)

| Statement | Non-daily/never users (<i>n</i> = 613) (%) | Daily users (<i>n</i> = 387) (%) | Group difference | |
|--|--|--------------------------------------|----------------------|-------------------------|
| | | | χ^2 (df = 1) | <i>p</i> |
| Active knowledge on hygiene as risk factor | 27.7 | 38.2 | 12.202 | <i><0.001</i> |
| Statements related to oral hygiene | | | | |
| To really get the teeth clean by daily brushing above all one has to brush them firmly (wrong) | 60.3 | 77.0 | 29.971 | <i><0.001</i> |
| To avoid periodontitis it is of particular importance to brush the chewing surfaces (wrong) | 35.7 | 44.7 | 8.133 | 0.004 |
| Statements related to the early diagnosis of periodontitis | | | | |
| The most frequent oral disease in adults is caries (wrong) | 24.3 | 37.5 | 19.940 | <i><0.001</i> |
| In early stages one recognizes periodontitis by frequent tooth aches (wrong) | 55.7 | 65.6 | 9.722 | 0.002 |
| Active knowledge on necessity of daily ($\geq 1/\text{day}$) interdental hygiene | 54.5 | 97.9 | 218.833 | <i><0.001</i> |

factor, useful brushing techniques (firmly brushing chewing surfaces), and the relative prevalence of caries. Furthermore, the very young (<20) and the seniors (≥ 60) were often the groups with the lowest percentage of correct answers. These data are in line with other studies from Jordan and Sweden indicating that knowledge deficits are found more often in less educated and older people (El-Qaderi & Quteish Ta'ani 2004, Martensson et al. 2006). Our data indicate that knowledge deficits are widely distributed across gender, education, and age groups. Thus, they provide no rationale for restricting educational efforts to specific target groups. Instead, the whole population must be addressed, even though less educated people, schoolchildren, and seniors seem to be somewhat more in need.

While our data indicate considerable need for oral health education in Germany, one should not expect an immediate effect on oral health from such efforts. Health behaviour models underline the significance of aspects such as self-efficacy expectations, decisional balance (relation of perceived benefits of and barriers to the behaviour), perceived susceptibility, and normative beliefs (Janz & Becker 1984, Rosenstock et al. 1988, Weinstein 1988, Ajzen 1991, Schwarzer 1992, Prochaska & Velicer 1997). Knowledge is just one factor affecting these issues. However, it can be considered at least a pre-condition for additional measures to improve oral health behaviour. People who do not know that daily interdental hygiene is necessary to maintain good oral health, and why this is so, will hardly accomplish it. Thus, most interventions to improve oral health include measures to improve oral health-related knowledge (e.g. Kakudate et al. 2009).

Indeed, knowledge of the necessity of daily interdental hygiene was the measure most strongly related to actual interdental health behaviour. The odds ratio for daily interdental hygiene in those knowing about its necessity as compared with those not knowing about it is 39.5 (95% confidence interval: 19.3; 81.1), resulting in a highly significant χ^2 measure (see Table 10). This corresponds to other findings of our group reporting a relationship between oral health knowledge and oral health behaviour or actual oral health (Granrath 2007, Hugoson et al. 2007, Deinzer et al. 2008). Interestingly, when we further analysed our data, it was additional knowledge related

to prevention and not knowledge on other topics that also showed a significant relationship with self-reported interdental health behaviour. This might indicate that it is more important to focus educational efforts on knowledge of preventive measures than on other knowledge topics. It might, however, also reflect topics focused on in dental practices, where patients are instructed to regularly carry out interdental oral hygiene measures. From studies on oral hygiene instructions in dental practices in Germany, we know that topics not immediately related to prevention are rarely discussed there (Deinzer & Granrath, unpublished data).

Regardless of the knowledge deficits relating to periodontitis, our data suggest a broad awareness of the general necessity of daily oral hygiene in Germany. More than 90% of our sample considered daily use of a toothbrush and toothpaste and >70% considered daily interdental hygiene to be necessary. However, only 70.3% report daily use of toothpaste and <40% practice daily interdental hygiene. Notwithstanding the strong relationship between knowledge and daily practice we reported above, these data again underline that any attempts to improve oral hygiene behaviour on a public level will have to go beyond mere knowledge transfer. We thus consider educational efforts to be but one step, albeit a fundamental one, in a more general approach to improving public oral health.

Summarizing, here we present the first study to assess periodontitis-related knowledge on a community level in Germany. We find broad deficits across all gender, educational, and age groups, although less educated and very young and old people tend to show the greatest deficits. Knowledge of preventive measures (hygiene techniques, meaning of plaque, early recognition of periodontitis) was found to be more strongly related to actual oral health behaviour than any other topic considered in the present survey. This implies that preventive measures should be the focus of future interventions.

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Address:
 Renate Deinzer
 Institute of Medical Psychology
 Justus-Liebig-University Giessen
 Friedrichstr. 36
 35392 Giessen
 Germany
 E-mail: rena.deinzer@psycho.med.uni-giessen.de

Clinical Relevance

Scientific rationale for the study: Health-related knowledge is a precondition for healthy behaviour. Thus, periodontitis-related knowledge and current oral health beha-

viour have been assessed in Germans on a community level.

Principal findings: We found severe deficits in periodontitis-related knowledge. All status and age groups are affected. Current oral health behaviour is most strongly related

to knowledge of prevention of periodontal diseases.

Practical implications: Improved health education on periodontal diseases is needed. These efforts should focus on measures for prevention.