J Clin Periodontol 2010; 37: 631–637 doi: 10.1111/j.1600-051X.2009.01513.x

Journal of Clinical Periodontology

A multi-centre and cross-sectional study of dentine hypersensitivity in China

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Que K, Ruan J, Fan X, Liang X, Hu D. A multi-centre and cross-sectional study of dentine hypersensitivity in China. J Clin Periodontol 2010; 37: 631–637. doi: 10.1111/j.1600-051X.2009.01513.x.

Abstract

Aim: The objective of this study was to establish the prevalence of dentine hypersensitivity (DH) in Chinese urban adults and the possible effects of smoking on DH.

Materials and Methods: A total of 2640 subjects were distributed equally in 12 communities in Chengdu and Xian City, respectively, and of all age groups (10 years for an age group) including the same number of male and female subjects in each community. Each subject completed a structured interview and the subjects who reported hypersensitivity symptoms were examined with cold air from a dental triple syringe in order to confirm the diagnosis of DH. Attachment loss and gingival recession of sensitive teeth were measured by a Williams periodontal probe.

Results: The diagnosis of DH established following a clinical assessment yielded an overall prevalence of 25.5%. The 50–59-year-old age group had the greatest number of subjects with DH ($p < 0.05$). 78.6% and 31.4% of sensitive teeth were associated with attachment loss and gingival loss, respectively. Subjects who smoked did not have more sensitive teeth on average than subjects who did not smoke ($p > 0.05$).

Conclusions: The prevalence of DH in a selected community population was 25.5%.

Key words: attachment loss; community population; dentine hypersensitivity; smoking

Accepted for publication 23 October 2009

Dentine hypersensitivity (DH) has been defined as a ''short, sharp pain arising from exposed dentine response to stimuli typically thermal, evaporative, tactile, osmotic or chemical and which cannot be ascribed to any other form of dental defect or disease'' (Canadian Advisory Board on Dentine Hypersensitivity 2003). DH is a common condition that is frequently encountered in dental practice. Several studies have reported that DH was found in adult populations, with prevalences ranging from 2.8% to 74% (Graf & Galasse 1977, Flynn et al. 1985, Orchardson & Collins 1987, Fischer et al. 1992, Murray & Roberts 1994, Rees 2000, Rees & Addy 2002, 2004, Taani & Awartani 2002, Rees et al. 2003, Udoye 2006). This wide variation in prevalence has been presumed to be due to a number of factors, including different methods used to diagnose the condition, variation in the type of sample population and the type of setting where the study was carried out.

Limited data have been collected previously from questionnaires studies rather than by clinical investigation (Murray & Roberts 1994, Irwin & McCusker 1997, Gillam et al. 2001). Most previous studies were mainly carried out in university hospitals or dental practices (Graf & Galasse 1977, Flynn et al. 1985, Orchardson & Collins 1987, Fischer et al. 1992, Rees 2000, Rees & Addy 2002, 2004, Taani & Awartani 2002, Rees et al. 2003, Udoye 2006), but these selected sample populations could experience more dental or periodontal diseases than in the general population. Many people with minor tooth sensitivity do not necessarily seek professional advice or dental treatment as well, making it more difficult to obtain an accurate prevalence of DH for the general population than for those in hospitals or clinics.

Some surveys of periodontal patient populations showed a higher prevalence of DH, ranging from 72.5% to 98% (Chabanski et al. 1996, 1997, Taani & Awartani 2002). Gingival recession can

Conflict of interest and source of funding statement

The authors declare that there were no potential conflicts of interests.
This study was supported by an educational grant from GlaxoSmithKline Consumer Healthcare Inc., and all authors declared that there were no potential conflicts of interest related to the publication of this paper.

result in exposure of the root surfaces and has been considered a common risk factor or contributing feature for subsequent DH, and some previous studies have reported prevalences of DH associated with gingival recession ranging from 29.7% to 93% (Chabanski et al. 1997, Rees 2000, Rees & Addy 2002, 2004, Taani & Awartani 2002). However, root surfaces may be exposed after periodontal attachment loss occurred and before gingival recession, and there are limited data on the relationship between loss of attachment and DH in the general population. Other previous studies had also highlighted a dose-dependent relationship between cigarette consumption and periodontal attachment loss (Grossi et al. 1994, Haffajee & Socransky 2001, Obradović 2007). The present study was designed to determine whether attachment loss was a risk factor/pre-disposing factor of DH, and whether the dose of smoking could also relate to the occurrence of DH to some degree in the general population.

A few studies (Adriaens et al. 1988, Dababneh et al. 1999) reported that bacteria can penetrate a significant distance into the dentine tubules and speculated that the DH associated with periodontal disease may have a different aetiology. As a result of this possibility, the European Federation of Periodontology have recommended the use of the term root sensitivity (RS) to describe the sensitivity associated with periodontal diseases and treatments (Rees & Addy 2004). The resultant prevalence figures in the present study included subjects with DH associated with RS due to periodontal disease. Further information on the prevalence of DH and associated risk factors in the general population may be beneficial in our understanding of the condition. The aim of the present study was to carry out a cross-sectional study of DH and to investigate the possible effects of smoking on DH in the general population of the urban communities in the cities Chengdu and Xian.

Materials and Methods

Practitioner training

The present study was a multi-centre and random sampling study in two selected Chinese cities namely Chengdu and Xian. All subjects were examined by one practitioner in each city, and both practitioners were trained professionally at the symposium on DH held by the Chinese Association of Dental Public Health (March 2008, Wuhan, China), where agreement was reached on the clinical methodology to be used in DH trials in this meeting. The calibration of DH and periodontal examination for uniformity and consistency between two examiners was performed and a standard κ test was conducted, with κ value >0.8. During the period of investigation, 5% of the subjects were randomly selected for DH re-examination to evaluate the consistency of the examiners.

Sources of sampling population

The aims of the investigation and the procedures involved in examination were explained in detail to every subject, who needed to provide their informed written consent before participating in the study. Adult subjects aged 20–69 years old were interviewed and divided into five age groups (20–29, 30–39, 40–49, 50–59 and 60–69). Because of limited data for DH in the general Chinese population, the expected prevalence (P) of DH in this study was estimated using available data from previous studies. Several previous studies that employed careful patient examination had all produced a similar prevalence result of about 15% (Graf & Galasse 1977, Flynn et al. 1985, Fischer et al. 1992), and so 15% was used as the expected prevalence of DH in the formula to calculate the sample size. However, to avoid underestimating the prevalence of DH, we increased the sample size by at least four times as follows:

$$n = \frac{4Z^2_{\alpha/2}P(1-P)}{L^2}$$

$\alpha = 0.05$, so $Z_{\alpha/2} = 1.96$; $P = 15\%$; L (95% CI) $= 0.10$; hence, $N = 4 \times 1.96^2 \times 0.15 \times 0.85/0.1^2 \approx 196$. For each city, every age group contained 240 subjects, yielding a total of 1200 for all five age groups. We then increased the sample size by 10% to 1320 in each city. As there were two cities, a total of 2640 subjects were included in our study.

The multi-stage and random sampling methods were performed in this study as follows: First, two districts were chosen randomly in each city, and then three communities were selected randomly in each district; second, we selected 220 subjects from each community, with each age group including 44 subjects (with equal number of males and females). We used the same sample sizes for each age group and each community to decrease biases of sample origin.

Questionnaire and clinical test

Questions about DH were read to the subjects, and answers were recorded by an assistant. Each subject's age, pain-inciting stimuli and duration of DH were asked and written down. Only subjects who reported having hypersensitivity symptoms in the questionnaire were further diagnosed by a blast of air from a triple syringe connected to an air compressor at a pressure of 60 psi under room temperature of about 20–25°C. This air jet, lasting for 3 s at a distance of 1 cm from the tooth surface (1 s for each surface, including the buccal, occlusal and lingual surface), was directed at the patient's tooth, and any uncomfortable feeling caused by the air stimuli was recorded on a clinical form according to different tooth types.

Exclusion criteria were based on Gillam et al. (2002) and modified slightly.

Subjects with any of the following conditions were not included in the study:

(1) Orthodontic appliances.
(2) Any disease requiring analgesic drugs, tranquillizers or mood-altering medication.

Teeth with any of the following conditions were not included in the study:

(1) root-filled teeth,
(2) crowned teeth,
(3) abutment teeth for dentures and bridge work,
(4) teeth with marginal restorations interfering with DH evaluation.

In addition to this, we measured any attachment loss and gingival recession associated with these sensitive teeth and all data were recorded on a clinical form according to different tooth types. Measurements were made using a 1 mm graduated periodontal probe (Williams periodontal probe). The tip of the instrument was placed with a light pressure of about 20 g into the gingival sulcus and the periodontal probe was kept parallel to the line angle of the root of the tooth. The deepest pocket depth around the sensitive position was recorded for buccal or lingual surfaces.

Data processing and statistical analysis

Statistical analysis was performed using SPSS 13.0 Chinese Edition (SPSS Inc., Chicago, IL, USA). The number of subjects with DH of different sexes and age groups were compared by a

χ^2-test. Other statistical analysis was performed by a two-sample *t*-test. The mean numbers of hypersensitive teeth per subject of the two investigated cities were compared by two-sample *t*-tests; the mean numbers of hypersensitive teeth, mean attachment loss and mean number of cigarettes smoked between different groups classified according to whether the subjects were smokers and had attachment loss were also compared by two-sample *t*-tests. A 95% level of significance ($p \leqslant 0.05$) was reached where a significant difference is reported in the text.

Results

Questionnaire

A total of 2640 subjects were included in this study. One thousand one hundred and one subjects reported hypersensitivity symptoms in the questionnaire, yielding an overall prevalence figure of 41.7%. Of the 1101, 667 were females and 434 were males, yielding an overall female to male ratio of 1.54 ($p < 0.01$). Figure 1a shows that the greatest number of subjects reporting hypersensitivity symptoms occurred in the 50–59-year-old age group, although the 40–49- and 60–69-year-old age group exhibited similar data. The least number of subjects reporting hypersensitivity symptoms was in the 20–29-year-old age group ($p < 0.01$). The most common type of stimuli for hypersensitivity was cold stimuli, followed by sour stimuli (Fig. 1b). The majority of subjects with DH reported having experienced hypersensitivity symptoms for >5 years (Fig. 1c).

Clinical test

Of all 1101 subjects reporting DH, 672 subjects were further diagnosed as having DH when clinically examined, yielding an overall prevalence of 25.5%. Of the 672, 439 were females and 233 were males, yielding a female to male ratio of 1.88 ($p < 0.01$). A total of 10,438 teeth were examined; 3088 teeth (29.6%) responded to cold air blast stimulus and 7350/10,438 (70.4%) did not respond to the test stimuli. The results of the clinical test produced surprisingly similar prevalence figures of about 25.5% in both investigation cities; however, the average number of sensitive teeth per subject was less in Chengdu than in Xian ($p < 0.01$) (Table 1).

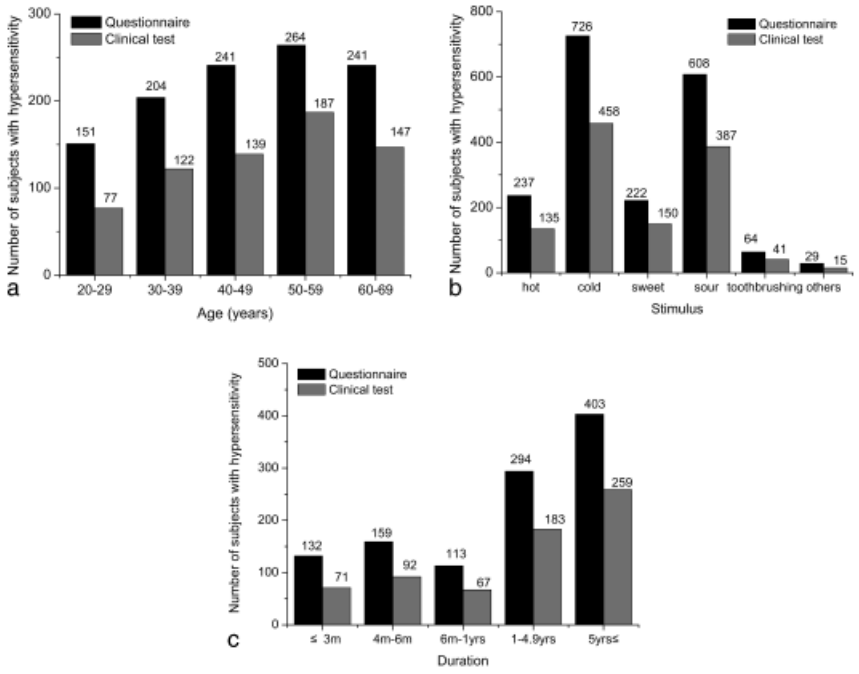

Fig. 1. (a) Age distribution of the subjects with dentine hypersensitivity (DH) in a questionnaire and a clinical test. (b) Frequency and sort of stimulus for the subjects with DH in a questionnaire and a clinical test. (c) Mean duration of symptoms for the subjects with DH in a questionnaire and a clinical test.

Table 1. Number and percentage of subjects with dentine hypersensitivity in Chengdu and Xian cities

	Intra-oral test (number, %)	Average number of sensitive teeth per subject with DH
Chengdu city	336 (25.5)	3.57*
Xian city	336 (25.5)	5.62*

Significant difference between the two groups.
*$p < 0.01$.
DH, dentine hypersensitivity.

Distributions categorized by age showed that the greatest number of subjects with DH as diagnosed by cold air blast stimulus occurred in the 50–59-year-old age group ($p < 0.05$), with the least number occurring in the 20–29-year-old age group ($p < 0.01$) (Fig. 1a). The frequency and type of stimuli as well as the duration of sensitivity symptoms for sensitive subjects diagnosed by the clinical test were fairly similar to the results obtained from the questionnaire (Figs 1b and c).

The presence of DH by tooth type showed that the pre-molar was the most commonly affected tooth, followed by the first molar, while the second molar was the least affected (Fig. 2).

Figure 3 shows the sum of attachment loss and gingival recession by tooth type when clinically examined. For most teeth, the distribution of attachment loss and gingival recession was similar to the distribution of DH by tooth type and the amount of attachment loss was

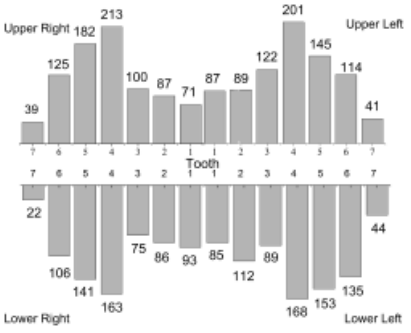

Fig. 2. Dentine hypersensitivity by tooth type in a clinical test.

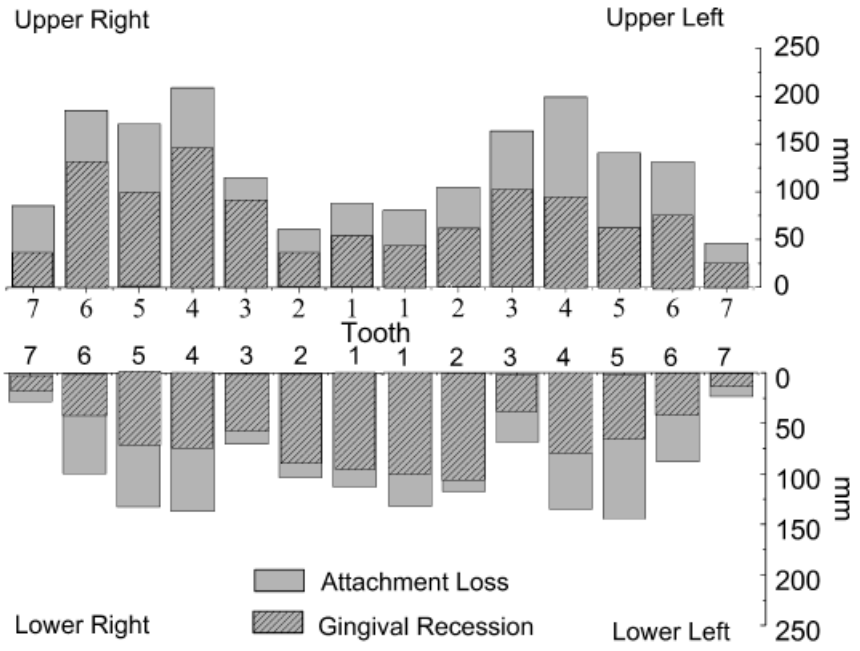

Fig. 3. Total amount of attachment loss and gingival recession by tooth type in a clinical test.

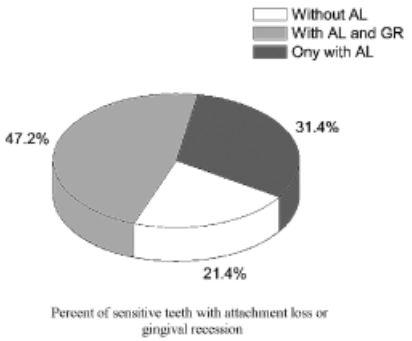

Fig. 4. Proportion of sensitive teeth with attachment loss and gingival recession.

usually remarkably higher than that of gingival recession.

Figure 4 shows that 2427/3088 (78.6%) of sensitive teeth were associated with some degree of attachment loss, and of these, 970/3088 (31.4%) were associated with gingival recession; 661/3088 (21.4%) of sensitive teeth did not have any attachment loss.

The relationships among smoking, attachment loss and DH are shown in Table 2. The data were classified according to whether the subjects were smokers or non-smokers and whether the sensitive teeth had attachment loss or not. No statistically significant differences were observed between the mean number of teeth with DH for the smoking and the non-smoking groups ($p > 0.05$). However, a relationship was observed between smoking and attachment loss, with the results indicating that subjects with DH who smoke have statistically greater attachment loss than subjects with DH who do not smoke ($p < 0.05$).

Furthermore, for those who both smoked and had DH, subjects with attachment loss demonstrated a statistically greater mean of cigarette consumption than subjects without attachment loss ($p < 0.05$). The difference between the mean number of cigarettes smoked in these two groups is shown in a more detailed graph (Fig. 5). The graph shows that the difference between the number of cigarettes smoked for the two groups grows wider with increasing age of the subjects, but starts to narrow slowly after 49 years old.

Discussion

A total of 2640 subjects were included in our study. The multi-stage, random sampling methods and equal numbers included of each age group and gender in our study were the main differences from previous studies. Furthermore, both the questionnaire and the clinical test were carried out on the general population in the two Chinese cities' communities. This multi-centre study observed that the total prevalence of DH was 41.7% according to the results of the questionnaire, and 25.5% according to the results of the clinical test. This prevalence was somewhat different from other published values. Some studies conducted in dental practices reported lower prevalence values from 2.8% to 15% (Graf & Galasse 1977, Rees 2000, Rees & Addy 2002, 2004), possibly due to the fact that most subjects investigated in these studies were below 50 years of age. Meanwhile, some studies with clinical examination in university clinics reported higher prevalence values of >30% (Orchardson & Collins 1987, Chabanski et al. 1997, Liu et al. 1998, Taani & Awartani 2002, Rees et al. 2003), which was probably a result of the smaller sample sizes and sample populations from the periodontology departments at the universities. However, a single diagnostic method in our study could not diagnose all sensitive teeth. As a result, the prevalence found in our study was estimated to be slightly less than the true DH prevalence for the general adult population in China. Although similar prevalences were found in both investigated cities, the average numbers of sensitive teeth per subject between the two cities were different. Different lifestyles and eating habits in the two cities could contribute to this disparity, which should be further researched.

In the present study, an air blast from a dental air syringe was used as a stimulus test and tactile sensitivity using a probe was not assessed in our study. Several previous studies (Rees 2000, Taani & Awartani 2002, Rees & Addy 2002, 2004 Rees et al. 2003) used only an air blast stimulus to clinically diagnose DH. However, other studies used both evaporative and tactile stimuli. Of these studies, Fischer et al. (1992) and Liu et al. (1998) reported that 95% and 92% of sensitive subjects were sensitive to an air blast stimulus. Chabanski et al. (1997) also reported that there was no statistically significant difference in the subjective response to tactile and evaporative stimuli. Absi et al (1987) had previously reported that usually only a limited area of the exposed dentine was actually sensitive and evaporative stimuli was more aggressive than tactile stimuli, and so if probes did not touch the sensitive area of sensitive teeth, some patients would not necessarily respond to the probe test but may only be sensitive to the air jet. The results of the present study are, however, comparable to those of previous studies. However, it is recognized that using only an air blast stimulus might not be capable of replicating all types of DH (Canadian Advisory Board on Dentine Hypersensitivity 2003), especially for the clinical trials, which need to

Table 2. Relationship among smoking, periodontal disease and DH

	Total number of subjects with DH	Mean number of sensitive teeth per subjects	Mean total number of attachment loss per subjects with DH	Mean total number of cigarettes of each subject with DH (thousand)
Smoker/periodontal disease	106	5.30	6.86**	158.75***
Smoker/no periodontal disease	31	2.43		96.23***
No smoker/periodontal disease	462	4.99	4.45**	
No smoker/no periodontal disease	73	1.95		

Significant difference between the two groups.
**$p<0.05$ and
***$p<0.01$.
DH, dentine hypersensitivity.

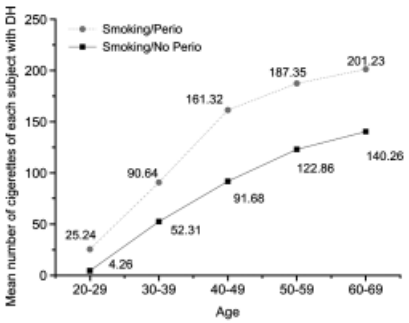

Fig. 5. Mean number of cigarettes of each subject with dentine hypersensitivity (DH).

be accurately compared before and after treatment, but for a prevalence study with a larger sample size, an air blast stimulus is still an effective method. As these provide data comparable to that previously recorded in the published literature, it could also be suggested that an air blast with both thermal and evaporative components is more comparable to stimuli experienced by subjects in real life than testing with a dental probe.

It is believed that DH occurs more commonly in females (Flynn et al. 1985, Fischer et al. 1992, Dababneh et al. 1999, Udoye 2006). The male–female ratios found by the questionnaire and clinical test also supported these findings ($p<0.01$). The reasons for this difference are not yet clear, but have been presumed to possibly relate to the fact that women have better overall healthcare and oral hygiene awareness, which would make them more sensitive to DH (Addy 1990). However, in our study, a number of females with sensitive teeth did not follow good oral hygiene procedures, especially female workers or labourers of lower socio-economic status, but sensitivity symptoms seemed to be ubiquitous. Females also appeared to be more sensitive to pain (Wiesenfeld-Hallin 2005, Miyazaki & Yamamoto 2009) and this physiological phenomenon may be another possible reason leading to the difference. However, certain cultural differences may also be present among easternized and westernized populations and females may report more pain symptoms than men in easternized cultures, where it may be less acceptable for a man to appear weak.

Some previous studies had reported on the age distribution of DH, and nearly every age group had been reported as the peak prevalence age group for some study. In previous studies, Orchardson & Collins (1987) reported the peak prevalence at ages 20–25, Graf & Galasse (1977) at ages 25–29, Liu et al. (1998) at ages 50–59, Rees (2000) and Rees & Addy (2002) at ages 30–39, Udoye (2006) at ages 31–40, Rees et al (2003) at ages 40–45 and Rees & Addy (2004) at ages 40–49. Our present study showed the highest prevalence occurring in the 50–59-year-old age group, as evaluated by cold air ($p<0.05$). This finding could be influenced by the fact that a balanced aged cohort was included in our study, which meant that more elderly people were included than recorded in other studies. Our result seemed to be more pertinent than some previous studies because tooth wear and periodontal disease become more common with ageing (Albandar & Kingman 1999). Declining hypersensitivity symptoms after the age of 60 may be due to the development of secondary or sclerotic dentine (Fischer et al. 1992), and previous studies have not necessarily included large numbers of subjects over 50 years of age due to extensive tooth loss, particularly in the posterior region, or having teeth that were excluded from testing due to heavily restored teeth.

Response to cold has often been cited as the most common stimulus for sensitivity, as was also found in this study, where most subjects identified cold as the most common pain-initiating stimulus. The second most prevalent stimulus was sour stimuli in the present study. This result disagrees with Fischer et al. (1992), Rees (2000), Rees & Addy (2002) and Rees et al (2003), who found heat to be the second most common pain-inducing stimulus. This difference might be related to the dietary pattern of different economical and cultural background. In our study, subjects who reported pain caused by sour stimuli were mainly elicited by fresh fruits. In China, with rapid economic development, fresh fruits, such as apple, citrus fruit and grape, have almost been daily necessities for most people. An in vivo study had shown that citrus fruit juices, apple juice and yogurt, etc. can dissolve the dentinal smear layer in minutes (Addy et al. 1987), which could explain why the hypersensitivity symptoms were frequently and rapidly caused by some sour stimuli.

The majority of subjects with DH had endured the condition for more than 5 years in this study. Rees et al (2003) also reported data similar to those in our study. Liu et al (1998) and Fischer et al (1992) found that the greatest number of the patients reported their DH to have lasted between 1 and 5 years, but most subjects of these studies were below 50 years old. The reason for these differences may be related to the different sample sizes used for different age groups, and the elderly cohorts may have a longer history of DH than those of the younger cohorts.

The teeth most often affected by DH were the pre-molars and first molars (Fig. 2). Most previous studies had also reported pre-molars and/or first molars as the most common sensitive teeth (Orchardson & Collins 1987, Fischer et al. 1992, Dababneh et al. 1999, Rees 2000, Rees & Addy 2002, 2004). Previous studies have reported that posterior teeth were more susceptible to refracture, which

may also be due to the fact that in some communities posterior teeth are heavily restored and therefore more susceptible to fracture (Tar et al. 2002); also, the first pre-molar was one of the teeth most frequently affected by gingival recession (Albandar & Kingman 1999, Tugnait & Clerehugh 2001). Taani & Awartani (2002) and Rees et al (2003) reported that lower incisors were one of the tooth types that were mainly affected, and different population sources, for example general population or periodontal patients, could contribute to the difference.

In this study, we found that the number of sensitive teeth associated with periodontal attachment loss was twice that of sensitive teeth with gingival recession. Attachment loss occurred before gingival recession and exposed root surfaces may be susceptible to acidic food and drink, which may soften the dentine, and subsequent tooth brushing with toothpaste may contribute to further tooth surface loss (Kassab & Cohen 2003). Similarly, an exposed enamelo-cemental junction easily led to a hypersensitivity symptom. As a result, periodontal attachment loss could be an earlier risk indicator for DH than gingival recession. In this study, no attachment loss was found in 21.4% of sensitive teeth. The enamel layer on the cervical region of the teeth was at its thinnest and was an area of structural weakness, and the combined effects of erosion, abrasion and abfraction (stress flexure) could usually remove the thin enamel layer or produce enamel disintegration (Lee & Eakle 1996, Addy 2002).

Two previous studies carried out in a general dental population have reported the relation between smoking and DH but the result was conflicting. Irwin & McCusker (1997) investigated by a questionnaire that although 67.6% of subjects with sensitivity also smoked, this relationship did not reach statistical significance ($p > 0.05$); Rees & Addy (2002) reported that the number of sensitive teeth per patient with periodontal disease who smoked was approximately double that of a smoker with no periodontal disease ($p < 0.05$), and meanwhile these patients also had greater amounts of gingival recession than other sensitive patients without smoking. In the present study, we concluded that smoking could not be the direct influential factor of DH, but smoking might affect DH to some degree by exacerbating periodontal attachment loss. Figure 5 shows clearly that the difference in the number of cigarettes smoked between groups with and without attachment loss became more apparent as age increased, but after 49 years of age, possibly because more elderly people gave up smoking or reduced the dosage of cigarettes, the gap between the two groups started to close. In our study, it was interesting to note that while female subjects accounted for the majority of sensitive subjects, only a few of them (15) smoked. Because of Chinese traditional cultural and social factors, most female adults do not smoke, which is different from the situation in some Western countries. Thus, smoking could be an influential factor of DH in some given area or population.

In conclusion, this cross-sectional study on DH in Chinese urban adults showed that the prevalence of DH in 20–69-year-old adults was 25.5%; however, 41.7% of the subjects reported by a questionnaire that they had at some point suffered uncomfortable hypersensitivity symptoms. Overall, the prevalence of DH became higher with ageing, hitting the peak in the 50–59-year-old age group. The first pre-molar was the most commonly affected tooth. Periodontal attachment loss could be an earlier indicator or a possible risk factor of DH, and smoking was not found to be the influential factor of DH in our study.

Acknowledgements

The study was supported by an educational grant from GlaxoSmithKline Consumer Healthcare Inc., and we would like to thank all the PhD and DDS staff in Department of Preventive Dentistry, West China College of Sichuan University and Stomatology College of Xi'an Jiaotong University for their help and advice during this study. We would also like to thank the Editor and Referees for their helpful and constructive advice in the publication of this paper.

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Clinical Relevance

Scientific rationale for the study: The sample population of our studies derived from healthy adults in the community, which was different from most previous published studies that were carried out in hospitals or dental practices. Furthermore, random sampling methods and equal number of subjects according to age and sex were also included in this study.

Principal findings: The prevalence of DH in a selected Chinese urban population was 25.5%. Subjects from 50- to 59-year-old age group could be the most susceptible, and the teeth that appeared to be the most often affected by DH were the premolars. Attachment loss may be an important risk factor of DH and as such could be an early risk indicator of DH for the condition. Smoking might increase susceptibility to DH by affecting DH to some degree by exacerbating periodontal attachment loss.

Practical implications: This study may provide more information on the prevalence of DH and any associated risk factors in a Chinese community population.