Oral Health Status and Prosthodontic Conditions of Chinese Adults: A Systematic Review

Qian Zhang, DDS, PhD[a]/Cees M. Kreulen, DDS, PhD[b]/Dick J. Witter, DDS, PhD[c]/
Nico H.J. Creugers, DDS, PhD[d]

Purpose: To assess oral health and prosthodontic conditions of Chinese adults and the changes in these conditions over time. ***Materials and Methods:*** PubMed was searched by combining the keyword *China* with *dental health survey*, *oral health*, *tooth loss*, *DMFT* (decayed/missing/filled teeth), *dental prosthesis*, or *dentures*. After selection, 12 studies remained. Data were obtained from these studies on DMFT, DMFT components, and teeth present and were tested against the following independent variables using analysis of variance: age, residence, and year of data collection. ***Results:*** DMFT increased with age ($P = .0001$). Rural subjects presented higher DMFT based on the higher "decayed" component ($P = .003$), which increased markedly for subjects over 45 years of age. The number of teeth present decreased with increasing age ($P = .0002$). The results showed that Chinese subjects who are 65 years old have an average of 20 teeth. Urban subjects had more teeth present ($P = .05$), although no difference was seen for the "missing" component of DMFT. In general, few prosthodontic data could be extracted from the selected studies, and these data were often unspecific or inconclusive. ***Conclusions:*** The "filled" component of DMFT remained consistently low for all ages, indicating limited care. All outcomes were independent from year of data collection, indicating unchanged care. Outcome aggregation on the number of functional teeth and prosthetic care was impossible. For future reports, it is recommended to include additional information about location and function (in terms of occluding pairs) of teeth present when describing oral health status. *Int J Prosthodont 2007;20:567–572.*

Epidemiologic studies provide the basis for estimating the oral health status of a population, and the results can be used to monitor changes in oral conditions over time. Using this information, future dental needs can be assessed. Whereas oral health care of children and young adults is mainly focused on caries prevention and restorative treatment, oral health care of adult and elderly patients is largely determined by improving oral function with tooth replacements. Aging populations face changing treatment needs, and the proportion of elderly patients in many countries is increasing, including in China. By 2050, it is anticipated that elderly persons will represent 24% of the Chinese population.[1,2] This implies that oral health conditions and treatment needs of older adults will become of increasing concern for the dental profession.

One index used to register oral health status is decayed/missing/filled teeth (DMFT). Unfortunately, the "missing" component of DMFT does not provide information regarding the type of missing teeth or whether they are functional in occlusion. This is of special interest with adults who show an increasing number of missing teeth. Oral function is less dependent on the number of single teeth present and more dependent on the number and location of occluding tooth pairs. For example, it was demonstrated that reduced denti-

[a]*Assistant Professor, Department of Prosthetic Dentistry, Affiliated Hospital of Medical College, Qingdao University, Shandong Province, China.*
[b]*Associate Professor, Department of Oral Function and Prosthetic Dentistry, College of Dental Science, Radboud University Nijmegen Medical Center, The Netherlands.*
[c]*Assistant Professor, Department of Oral Function and Prosthetic Dentistry, College of Dental Science, Radboud University Nijmegen Medical Center, The Netherlands.*
[d]*Professor and Chair, Department of Oral Function and Prosthetic Dentistry, College of Dental Science, Radboud University Nijmegen Medical Center, The Netherlands.*

Correspondence to: *Dr Nico H.J. Creugers, Department Oral Function and Prosthetic Dentistry, Radboud University Nijmegen Medical Center, PO Box 9101, 6500 HB Nijmegen, The Netherlands. Fax: +31 24 36541971. E-mail: n.creugers@dent.umcn.nl*

Table 1 Inclusion and Exclusion Criteria for the Selection of Papers in 2 Steps

Step 1: Abstracts	
Include	In English and Chinese On adults (≥ 21 years) Subjects living in mainland China, Hong Kong, Macao, or Taiwan Regional or local survey Clinical examination
Exclude	Specific populations (eg, military)* Intervention studies, reviews Studies not meeting *all* inclusion criteria
Step 2: Full text	
Include	Samples of "normal" target population Outcome data on DMFT or components of DMFT and/or prosthodontic situation Ages or age cohorts presented Place of residence (urban/rural) mentioned
Exclude	Studies not meeting *all* inclusion criteria

*Articles can be used if the samples include not only a specific group, but also a "normal" target population.

tions with intact anterior and premolar regions can provide adequate oral function.[3–5] There is an intimate relationship between the occluding tooth pairs lost and the treatment need to restore or maintain a functional dentition using prosthodontic appliances.[3]

Most oral health surveys in China are focused on children and adolescents. The few available data on adults are difficult to interpret because of variations in sampling methods, research criteria, and (analyses of) variables.[6] Thus, for a proper estimation of treatment needs and demands in China, it is imperative that the published data are structured and aggregated to improve their power.

The objective of the current study was to systematically review DMFT and number and location of teeth present in Chinese adults and to consider the need for prosthodontic appliances.

Materials and Methods

The literature was searched using the PubMed database for studies published between 1980 and November 2005. The key words used were: *China* combined with *dental health survey*, *oral health*, *tooth loss*, *DMFT*, *dental prosthesis*, or *dentures*.

Inclusion/Exclusion Criteria

The first step was the selection of references according to criteria shown in Table 1. Two authors independently selected the references on the basis of abstracts. If abstracts were not available in PubMed, original published articles were obtained. Observer agreement was analyzed. Disagreements were resolved by discussion.

In the second step, full-text versions of the selected references were obtained. Copies were blinded by deleting information that identified the origin of the papers. Only "Aim," "Materials and Methods," and "Results" sections were read. A native Chinese speaker translated papers published in Chinese into English. The reviewers selected the papers independently according to additional criteria (Table 1). Again, observer agreement was analyzed and disagreements were resolved by discussion.

References in the papers included were cross-matched with the original list of references to add references that met the inclusion criteria. Papers with data based on the same population were clustered.

Data Extraction

The following outcomes were extracted to construct a clinical data set: mean values (SDs) or proportions (SEs) of DMFT, components of DMFT, number of present teeth, number of roots, number of occluding teeth, edentulousness, and prosthodontic provisions (fixed partial dentures, removable partial dentures, and crowns). Outcomes were included only if they were presented according to the independent variables: age, gender, and place of residence.

Outcomes were taken from tables, graphs, and text in "Results" sections. To prevent misreading, relevant graphs were electronically scanned from the original journal prints (resolution: 999 dpi) and printed. X-y coordinates of relevant measurement points in enlarged figures were estimated with the help of construction lines.

Unfortunately, not all selected studies complied with the World Health Organization's (WHO) criteria on DMFT, eg, one study included enamel lesions in the "decay" component. These outcomes were converted by subtracting the enamel lesions from the total. A second problem was that all but 2 studies included edentulous subjects in their DMFT calculations. For the present analysis, the outcomes of the 2 studies excluding edentulous subjects were recalculated as follows:

For M and DMFT values:

$$\text{Mean}_{\text{New}} = (\text{Mean}_{\text{Dentate}} \times \text{Subjects}_{\text{Dentate}} + 32 \times \text{Subjects}_{\text{Edentulous}}) / \text{Subjects}_{\text{All}}$$

For D and F values:

$$\text{Mean}_{\text{New}} = (\text{Mean}_{\text{Dentate}} \times \text{Subjects}_{\text{Dentate}}) / \text{Subjects}_{\text{All}}$$

For SDs:

$$\text{SD}_{\text{New}} = \text{SD}_{\text{Dentate}} \times \text{Subjects}_{\text{Dentate}} / \text{Subjects}_{\text{All}}$$

Table 2 Included Clusters of Articles

Study	Reference(s)	Year of data collection*	Place of research	Place of residence	Age cohort (y)	Sample size†
1	McMillan et al[7] Wong et al,[8]	2000	Hong Kong	Urban	60–80	586
2	Wang et al[9] National Committee of Oral Health[1]	1995–1996	11 provinces	Urban/rural	35–44 65–74	23,452 23,452
3	Wong et al[10]	2000	Hong Kong	Urban	60–80	1,023
4	Lin et al[11] Lin et al[12]	1997	Guang Dong	Urban/rural	35–44 65–74	1,573 1,515
5	Luan et al[13] Baelum[14] Luan et al[15] Luan et al[16] Luan et al[17] Baelum et al[18]	1984 1994	Beijing	Urban/rural Rural	30–39 40–49 50–59 60–69 ≥ 70	300 (78) 300 (94) 300 (89) 359 (93) 185 (86)
6	Corbet and Lo[19] Lo and Schwartz[20]	1991	Hong Kong	Urban	35–44 65–74	372 537
7	Chen et al[21]	1990	Guang Dong	Urban/rural	30–34 35–44 45–54 55–64 ≥ 65	1,575 2,653 1,702 1,478 1,025
8	Hu et al[22]	1986	Shang Hai	Urban	60–64 65–69 70–74 75–79 ≥ 80	576 416 288 192 128
9	Lind et al[23]	1984	Hong Kong	Urban	35–44	676
10	Beijing Committee[24]	1987	Beijing	Urban	60–69 70–79 ≥ 80	1,390 656 145
11	Powell et al[25]	1985	Shan Dong	Urban	35–44	154
12	Petersen et al[26]	1995	Hu Bei	Urban/rural	35–44 65–74	417 240

*If year of data collection was not presented in the paper it was considered to be year of publication minus 1 year.
†Data in parenthesis for study 5 are the numbers of rural subjects in 1994.

A third problem was that SDs were sometimes presented as "smaller than" instead of the exact value. For instance, "SD $<$ 0.1" was interpreted as "SD $=$ 0.1." Imprecise data (eg, "D $<$ 2.3" or "age group ≥ 70 years") were discarded.

Statistical Analysis

Cohen kappa was used to assess agreement between the reviewers during the 2 steps of the study selection. Incompatibility of the independent variables between the studies required adjustment in some cases. To construct age-dependent scatter plots of outcome variables (such as DMFT), reference ages were required instead of the often-presented broad age cohorts. Age cohorts were converted or recalculated using interpolation of means based on linear regression (eg, a 10-year age cohort of 35 to 44 years was converted to the mean reference age of 40 years). Age cohorts spanning 5 years (eg, 60 to 64 years and 65 to 69 years) were transferred to a single age cohort of 10 years (60 to 69 years) with 65 as the mean. In this way, the age cohorts could be converted to mean reference ages of 35, 45, 55, and 65 years. For some studies, mean reference ages of 40 and 70 years were used.

Generally, outcomes are related to male/female distributions. However, some studies did not present gender ratios or outcomes according to male/female proportions (Table 3). Therefore, gender could not be included in the analysis. Place of residence was indicated as either *urban* or *rural*.

Finally, the year of data collection was added to the analysis, and studies were grouped as *(1)* data collected before or during 1990 or *(2)* data collected after 1990. If not indicated in the paper, the year of publication minus 1 was considered to be year of data collection.

Variables and outcomes (in terms of means and SDs, either as presented in the primary study or as recalculated, and sample size) were subjected to analysis of variance (ANOVA) models. SEs were converted to SDs: $SD = SE \times \sqrt{(n - 1)}$. If SDs could not be derived, analyses were performed based only on means.

Table 3 No. of Selected Studies According to Included or Not Included Variables

Variable	Included	Not included
Independent variables		
Place of residence	12	0
Age	12	0
Gender		
Overall gender ratio	10	2
Outcomes related to males/females	8	4
Year of data collection	12	0
Outcome variables		
DMFT	11	1
D	9	3
M	10	2
F	9	3
No. of teeth present	5	7
No. of functional teeth	2	10
% edentulous subjects	10	2
Prosthodontic status	6	6

Results

The PubMed search resulted in 281 references: 245 in English, 32 in Chinese, and 4 in other languages. Based on titles and abstracts, 48 references were included and 233 excluded after the first selection step (Table 1). Full agreement was observed for 263 articles. Observer agreement was substantial: kappa = 0.73 ± 0.06. Excluded studies were *(1)* not performed in China, eg, Chinese populations outside China (n = 32); *(2)* commentaries, reviews, etc (n = 73); *(3)* on nontarget populations, eg, drug users (n = 75); or *(4)* on other study purposes, eg, water fluoridation (n = 53).

Based on the additional information from the full-text copies, 18 papers were included after the second step (Table 1) and 30 were excluded. Observer agreement was very good (kappa = 0.83 ± 0.08). Of the excluded papers, 9 reported no relevant data or no data at all, but were complementary to some of the included studies, eg, added periodontal information. Thirteen papers produced the desired outcomes, but appeared to deal with nontarget populations. Eight papers were excluded because the full text provided unrevealed information (eg, outcomes based on subjects' self-assessments instead of clinical examinations).

Eleven different studies were identified among the 18 selected papers. Hand searches through the reference lists revealed 2 unidentified papers that met the inclusion criteria (Table 2). The paper by Bealum et al[18] belonged to a series of papers already included, while the paper of Petersen et al[26] was added as an independent study. Furthermore, a Chinese report was obtained[1] that provided additional data for the article by Wang et al.[9] In total, 21 articles representing 12 different studies were available for data extraction. Four of these provided data collected before 1990, while 7 provided data collected after 1990. One study provided data from both periods (Table 2).

No study included all of the outcome variables (Table 3). Data on the number of functional teeth were included in only 2 studies. Outcome data on prosthodontic status were incompatible: those before 1990 included detailed information (eg, number of removable partial dentuers), whereas studies after 1990 presented data only mentioning the presence of "any prosthetic device." As a result, statistical analyses were considered to be meaningful only for the outcomes DMFT and DMFT components, number of teeth present, and percentage of edentulous subjects.

The ANOVA based on the means, SDs, and sample size appeared to be meaningless, since one study (Table 2, study 2[1,9]) determined the analysis for over 92% as a result of its sample size. Moreover, SDs could only be obtained for or calculated from data collected from the studies performed after 1990. Therefore, ANOVA based on means only was performed.

The means included in the ANOVA and the estimated overall means (including standard error of the mean [SEM]) are presented in Figs 1 to 3. The variation in the outcomes for 70-year-old subjects was large, and outcomes for this age group did not fit the model. Nevertheless, point estimates are included in the figures. Since outcomes were independent from the year of data collection (*P* values range from .07 for D to .86 for number of teeth present), all studies were combined and no differentiation between "before 1990" and "after 1990" was applied.

Combined outcome data showed that DMFT increases significantly with age ($P = .0001$; Fig 1). Rural subjects presented significantly higher DMFT and D for all reference ages ($P = .003$). The "decayed" component increased for subjects 45 years and older, whereas the "filled" component remained constant just below 1 for all ages ($P = .99$; Fig 2). Place of residence was not of influence to D and F ($P = .25$). The number of teeth present decreased with increasing age ($P = .0002$; Fig 3). Chinese subjects aged 65 years were estimated to have an average of 20 teeth. Urban subjects showed more teeth present ($P = .05$) than rural subjects, although no difference was seen for the "missing" component ($P = .22$).

Based on the scarce data reported in the selected studies, the percentage of edentulous subjects was estimated to run from 3% for subjects aged 55 years to 12% for subjects aged 65 years to about 15% for subjects 70 years of age. The prevalence of edentulousness among adults 45 years and younger was estimated to be less than 1%. No data on occlusal pairs or location of missing teeth or on prosthetic appliances could be derived from the selected papers.

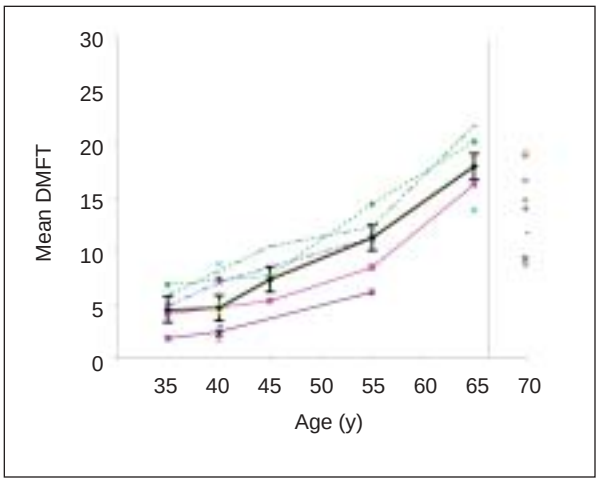

Fig 1 Scatter graph of DMFT according to age. Mean values from studies 5 and 7 are connected by solid lines (urban areas) or dotted lines (rural areas). Values for age 40 originate from studies 2, 4, 6, 9, 11, and 12; values for age 70 originate from studies 1, 2, 3, 4, 6, 9, 11, and 12 (numbers refer to the list of clustered studies in Table 2). The bold line with the SEM connects the calculated overall mean values. Estimates for age 70 are presented but not included in the analysis.

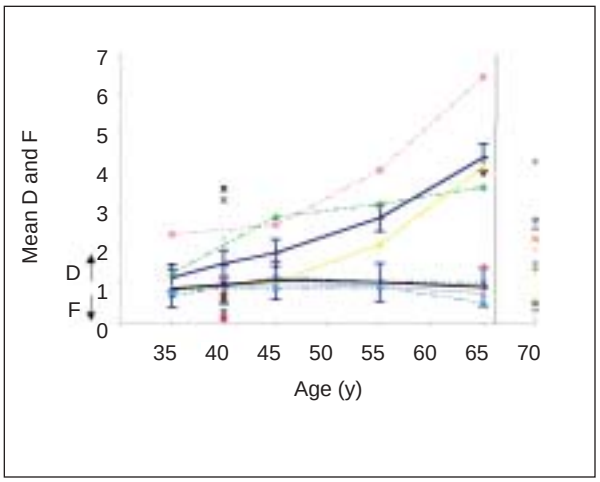

Fig 2 Scatter graph of the components "decayed" (D) and "filled" (F) teeth according to age. Mean values from studies 5 and 7 are connected by solid lines (urban areas) or dotted lines (rural areas). Values for age 40 originate from studies 2, 4, 6, 9, 11, and 12; values for age 70 originate from studies 1, 2, 3, 4, 6, and 12 (numbers refer to the list of clustered studies in Table 2). The bold line with the SEM connects the calculated overall mean values. Estimates for age 70 are presented but not included in the analysis.

Discussion

This study systematically analyzed the existing knowledge regarding the oral health status and prosthetic status of Chinese adults in terms of DMFT, DMFT components, and some other variables. Because of inconsistencies between studies and varying reporting designs, some approximations of data had to be made. It is reasonable to assume that different choices regarding data recalculations will influence study outcomes.

Unfortunately, the reviewed literature did not provide sufficient information to reach all aims set for the present study. With older adults, the (distribution of) remaining occlusal tooth pairs is a concern for maintaining oral function, but not even a single study was aware of the importance of the information that they had possibly acquired on this topic. Moreover, gender differences may be a reason for different approaches, but not all study outcomes were related to gender. Although gender could not be included in the analyses, it is worth mentioning that few studies showed that females had significantly higher DMFT than males.[9,20] For elderly subjects with the reference age of 70 years, the outcomes showed a large variation and were generally lower than expected from extrapolation of the overall means. A post-hoc ANOVA including these outcomes did not fit the model. The variation can be explained by differences in composition of the age cohorts in terms of imprecise estimations of the mean reference age, gender ratio, and the background of the selected elderly groups.[7,8]

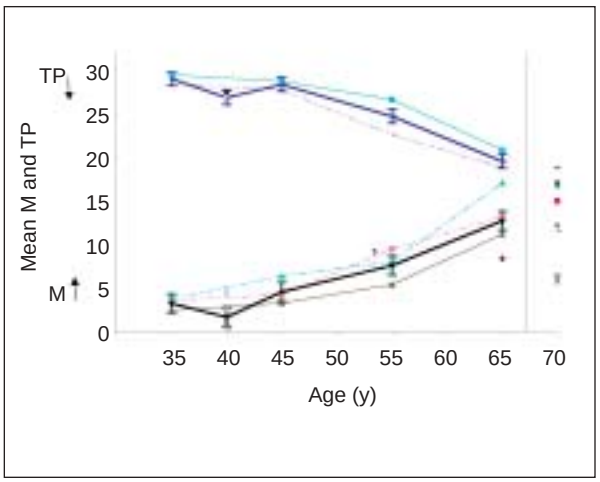

Fig 3 Scatter graph of the "missing" (M) component and teeth present (TP) according to age. Mean values from study 5 are connected by solid lines (urban areas) or dotted lines (rural areas). Values for age 40 originate from studies 2, 4, 6, 9, 11, and 12; values for age 70 originate from studies 1, 2, 3, 4, 6, and 12 (numbers refer to the list of clustered studies in Table 2). The bold line with the SEM connects the calculated overall mean values. Estimates for age 70 are presented but not included in the analysis.

Rural adults had higher DMFT than urban adults because of the significantly higher "decay" component. It is reported that there was minimal knowledge on prevention among the rural residents and a limited use of fluoridated toothpastes in these areas.[27] More than half of this population reported never to have received any oral health education. The lack of preventive programs is also affected by the very low number of

dental personnel relative to the population, with an unknown but high number of unlicensed middle-level dental workers.[28] Overall, DMFT levels in this study are relative low compared to global figures.[29]

With respect to the second aim—consideration of treatment need and demand as related to oral function—few data could be obtained on the location of lost teeth and the number of occluding tooth pairs. As a result of conflicting outcomes from 2 studies,[11,17] no conclusions could be drawn. Regarding the prosthodontic situation, the information was often outdated (before 1990) or unspecified. Consequently, possible changes in prosthodontic needs were undetectable in this review. Since the "filled" component remained low over time while the "decayed" component steadily increased with age, it is assumed that dental care, including prosthodontic services, is scarce for Chinese adults.

Conclusions

As a result of inconsistencies between studies and varying reporting designs, the reviewed literature did not provide sufficient information to reach all aims set for the present study. It is recommended to use fully described and institutionally accepted standards for data collection and reporting when describing epidemiologically based oral health status (eg, WHO criteria for DMFT). Data on missing teeth are much more valuable for describing oral health status when additional information is provided about the location and function (in terms of occluding pairs) of the teeth present.

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