Correlation Analysis between Self-perceived Oral Health and Self-perceived General Health among Adults in China

Yi Zhen YU[1], Shuo DU[1], Min DING[1,2], Zhi Ying CUI[1], Yi LIU[2], Yan SI[1]

Objective: *To analyse the correlation between self-perceived oral health (SPOH) and self-perceived general health (SPGH) and the influencing factors.*
Methods: *In this study, we collected sociodemographic information and details about SPOH and SPGH status for Chinese adults (≥ 18 years), and a total of 2233 people were included. The data were analysed using SPSS software (IBM, Armonk, NY, USA) with a chi-square test and binary logistic regression.*
Results: *In total, 43.4% of adults' self-perceived oral health was at a "good" level and 57.9% of adults' self-perceived general health was at a "good" level. The SPOH was correlated with SPGH ($r = 0.593$, $P < 0.001$). Good SPOH was associated with younger age, no dentures, no smoking, brushing teeth twice or more a day, periodontal health, no malocclusion and decayed, missing and filled teeth (DMFT) ≤ 12. Good SPGH was associated with younger age, higher educational level, no dentures, no smoking, brushing teeth twice or more a day, periodontal health, no malocclusion and DMFT ≤ 12.*
Conclusion: *SPOH and SPGH are correlated with each other, and greater attention should be paid to oral health to promote general health.*

Key words: *adults, China, correlation, general health, oral health*
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Health is an important factor that contributes to longevity, successful ageing and satisfaction with life[1]. An increasing number of studies have found many links between oral health and general health, and people around the world are paying closer attention to the relevance of both. The World Dental Federation (FDI) defines oral health as "the health of the mouth. No matter what your age, oral health is vital to general health and well-being"[2].

Oral health is an integral component of general health[3]. Many systemic diseases and oral diseases interact with each other, and periodontitis is a risk factor for cardiovascular disease. Researchers have found that periodontitis is associated with myocardial infarction[4], periodontitis and tooth loss are associated with the occurrence of stroke[5], and severe tooth loss is significantly related to incident coronary heart disease[6]. In addition, diabetes mellitus[7,8], respiratory diseases[9], preterm birth[10] and underweight children[11] are all associated with periodontal disease.

Self-perceived general health (SPGH) can be a sensitive barometer of physiological states, and it covers a large spectrum of health conditions[12]. Many studies have shown that SPGH, with individuals asked a

1 Department of Preventive Dentistry, Peking University School and Hospital of Stomatology, National Engineering Laboratory for Digital and Material Technology of Stomatology, Beijing Key Laboratory of Digital Stomatology, Beijing, P.R. China.
2 Department of Orthodontics, Peking University School and Hospital of Stomatology, National Engineering Laboratory for Digital and Material Technology of Stomatology, Beijing Key Laboratory of Digital Stomatology, Beijing, P.R. China.

Corresponding authors: Dr Yi LIU, Department of Orthodontics, Peking University School and Hospital of Stomatology, #22 Zhongguancun South Avenue, Haidian District, Beijing 100081, P.R. China. Tel: 86-10-82195561; Fax: 86-10-62110880. Email: lyortho@163.com

Dr Yan SI, Department of Preventive Dentistry, Peking University School and Hospital of Stomatology, #22 Zhongguancun South Avenue, Haidian District, Beijing 100081, P.R. China. Tel: 86-10-82195561; Fax: 86-10-62173404. Email: siyanyy@163.com

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simple question to rate their overall health on a scale from excellent to poor, is a strong predictor of future morbidity and mortality[13-15]. SPGH and self-perceived oral health (SPOH) are commonly used health and oral health indicators in most national and international surveys. SPOH has also been found to be significantly associated with clinical oral health status[16], and has been suggested as a health assessment tool[17].

However, relatively few studies have explored the relationship between SPOH and SPGH status in China, and the results were often obtained from a very simple questionnaire. Based on this background, the purpose of this study was to explore Chinese adults' evaluation of their own oral health and general health, the correlation between the two, and the influencing factors.

Materials and methods

Subjects

This cross-sectional study used data from the 2020 Oral Health Observatory (OHO). The target population was residents aged 18 and above in China.

The sample size was

$$\mathbf{n}= \boldsymbol{deff}\frac{\mu^{2}_{\alpha/2}p(1-p)}{\delta^{2}}$$

deff is the design efficiency, *p* is the prevalence of dental disease in the group aged 35 to 44 years from the 4th National Oral Health Survey, μ is the level of confidence and δ is the relative error. Considering the expected response rate of 85%, the estimated sample should be composed of no fewer than 2163 people. Systematic cluster sampling was conducted by the sample of registered members of the Chinese Stomatological Association (CSA) ordered by the initials of their region, with a final sample size of 2233 people.

Data collection and methods

The questionnaire delivered to participants covered their age, sex and education and other demographic information, information related to oral health behaviour such as wearing dentures, smoking, tooth brushing and intake of sugary food, as well as SROH and SRGH, which were filled in by the participants themselves. After oral examination by dental practitioners, a record that included information about oral disease, such as periodontal health, decayed, missing and filled teeth (DMFT) and dental erosion, was completed by dental practitioners. The questionnaire and record were combined by matching the same patients' information. All the information from the online questionnaire and the record was collected using mobile phone application software.

For the questions answered by patients, the options for SPOH and SPGH were "very good", "good", "general", "poor" and "very poor", which were recoded so that "very good" and "good" were grouped under "good" and the other options were classified as "poor". The age groups were 18 to 24 years, 25 to 34 years, 35 to 44 years, 45 to 54 years and 55 years and over. DMFT was categorised into four groups based on experience of caries lesions (DMFT 0, 1 to 5, 6 to 12 and > 12). Our classification of DMFT referred to the group aged from 35 to 44 years' mean DMFT (4.54) which was rounded up to 5, from the Fourth National Oral Health Survey (2015 to 2016) in mainland China, and the median DMFT was 6 in our study. Our analysis revealed little group differences in the groups of DMFT ≤ 12, so we considered the group of DMFT > 12 as a group in which caries were severe.

Statistical analysis

All statistical analyses were performed using SPSS Statistics v. 26.0 (IBM, Armonk, NY, USA). A nonparametric test (Mann-Whitney U test) was performed to compare the indices. Chi-squared tests were then used to examine the potential correlation between SPOH and SPGH and their respective potential association between SPOH and SPGH, both as dependent variables, and the different study variables (independent variables). Multivariate binary logistic regression analysis was used to determine the related factors affecting SPOH and SPGH. All statistical tests were performed with a level of significance of $P < 0.05$.

Results

Basic information

A total of 2233 subjects were selected, 1292 of whom were women and 941 were men. In terms of education, secondary education and a bachelor's degree or above were reported most frequently (38.4% and 56.0%, respectively). Only 7.4% of participants reported having worn dentures, 26.7% smoked or had smoked previously, 79.4% brushed their teeth twice or more a day, and up to 91.3% and 83.9% consumed sugary foods and drinks, respectively. The overall periodontal health rate

Table 1 Characteristics of the study sample.

Variable		n	%
Age, y	18–24	425	19.0
	25–34	762	34.1
	35–44	428	19.2
	45–54	300	13.4
	> 55	318	14.2
Sex	Male	941	42.1
	Female	1292	57.9
Education	Primary education or less	123	5.6
	Secondary education	832	38.4
	Bachelor's degree or higher	1213	56.0
Dental prosthesis	Yes	166	7.4
	No	2067	92.6
Smoking	Yes	597	26.7
	No	1636	73.3
Brush teeth twice or more a day	Yes	1741	79.4
	No	452	20.6
Consumption of sugary food	Yes	2023	91.2
	No	194	8.8
Consumption of sugary drinks	Yes	1852	83.9
	No	355	16.1
Periodontal health	Yes	830	37.8
	No	1365	62.2
DMFT	0	160	7.6
	1-5	708	33.7
	6-12	904	43.0
	>12	330	15.7
Acid erosion	Yes	469	21.1
	No	1757	78.9
Malocclusion	Yes	343	15.4
	No	1890	84.6
Good SPGH	Yes	1290	57.9
	No	937	42.1
Good SPOH	Yes	964	43.4
	No	1262	56.6

was 37.8%, the proportion of caries-free participants was 7.6%, the prevalence of dental erosion was 21.1% and the prevalence of malocclusion was 15.4%. A total of 43.4% of participants considered their oral health to be good. In contrast, up to 57.9% thought they had good general health. All of the variables are shown in Table 1.

SPOH and SPGH

Comparison of DMFT groups showed a significant difference between DMFT > 12 and the remaining DMFT ≤ 12 groups in the univariate analysis of SPOH and SPGH, but no significant difference between the DMFT ≤ 12 groups. The variables that affected SPOH were younger age, female sex, higher education level, no dentures, no smoking, brushing teeth twice or more a day, eating sugary food, drinking sugary drinks, periodontal health, DMFT ≤ 12, no dental erosion and no malocclusion (Table 2). These variables were associated with better SPOH.

The variables that were associated with good SPGH were consistent with good SPOH, such as younger age, female sex, higher education level, no dentures, no smoking, brushing teeth twice or more a day, drinking sugary drinks, periodontal health, DMFT ≤ 12, no dental erosion, and no malocclusion (Table 3).

Correlation between SPOH and SPGH

Table 4 shows that SPOH and SPGH are positively correlated and subjects with good SPOH had good SPGH, whereas those with poor SPOH had poor SPGH. A Spearman correlation coefficient showed a moderate

Table 2 Distribution of SPOH according to the different variables. A chi square test was used.

Variable			SPOH				*P* value
			Good		Not good		
			n	%	n	%	
Social demographics	Age, y	18–24	232	55.0	190	45.0	< 0.001
		25–34	387	50.9	373	49.1	
		35–44	173	40.6	253	59.4	
		45–54	97	32.3	203	67.7	
		> 55	75	23.6	243	76.4	
	Sex	Male	353	37.6	585	62.4	0.001
		Female	611	47.4	677	52.6	
	Education	Primary education or less	26	21.3	96	78.7	< 0.001
		Secondary education	304	36.8	522	63.2	
		Bachelor's degree or higher	605	49.9	608	50.1	
Oral hygiene habits	Dental prosthesis	Yes	31	18.7	135	81.3	< 0.001
		No	933	45.3	1127	54.7	
	Smoking	Yes	172	28.9	423	71.1	< 0.001
		No	792	48.6	839	51.4	
	Brush teeth twice or more a day	Yes	827	47.6	912	52.4	< 0.001
		No	123	27.5	325	72.5	
	Sugary food consumption	Yes	887	44.0	1131	56.0	0.019
		No	68	35.1	126	64.9	
	Sugary drink consumption	Yes	848	45.9	999	54.1	< 0.001
		No	108	30.4	247	69.6	
Oral disease	Periodontal health	Yes	463	56.1	363	43.9	< 0.001
		No	487	35.8	875	64.2	
	DMFT	0	85	53.1	75	46.9	< 0.001
		1–5	369	52.3	337	47.7	
		6–12	381	42.3	520	57.7	
		> 12	78	23.8	250	76.2	
	Acid erosion	Yes	173	37.1	293	62.9	0.003
		No	788	45.0	965	55.0	
	Malocclusion	Yes	124	36.4	217	63.6	0.005
		No	840	44.6	1045	55.4	

correlation but was statistically significant ($r = 0.593$; $P < 0.05$).

Multivariate analysis

Multivariate binary logistic regression analysis showed worse SPOH in the age groups above 35 years compared to the group aged 18 to 24 years. No dentures, no smoking, brushing teeth twice or more times a day, periodontal health, no malocclusion and DMFT ≤ 12 were positively related to good SPOH (Table 5).

The influencing factors of SPGH were similar to those of SPOH. The group aged 25 to 34 years had poor SPGH compared to those aged 18 to 24 years. Higher education, no dentures, no smoking, brushing teeth twice or more times a day, sugary drink intake, periodontal health, no malocclusion and DMFT ≤ 12 were factors influencing SPGH (Table 6).

Discussion

In the present study, the same independent variables were used to assess the factors associated with SPGH and SPOH. The results showed that in Chinese adults, good SPGH and good SPOH were associated with demographic information, oral health behaviours and oral disease factors, and there were many common influencing factors between the two. An individual's self-perceived health represents a summary statement concerning the ways in which various aspects of health, subjective and

Table 3 Distribution of SPGH according to the different variables. A chi-square test was used.

Variable			SPGH				*P* value
			Good		Not good		
			n	%	n	%	
Social demographics	Age, y	18–24	281	66.4	142	33.6	< 0.001
		25–34	491	64.6	269	35.4	
		35–44	227	53.3	199	46.7	
		45–54	154	51.3	146	48.7	
		> 55	137	43.1	181	56.9	
	Sex	Male	500	53.2	439	46.8	0.001
		Female	790	61.3	498	38.7	
	Education	Primary education or less	34	27.6	89	72.4	< 0.001
		Secondary education	415	50.1	414	49.9	
		Bachelor's degree or higher	805	66.5	405	33.5	
Oral hygiene habits	Dental prosthesis	Yes	55	33.1	111	66.9	< 0.001
		No	1235	59.9	826	40.1	
	Smoking	Yes	254	42.7	341	57.3	< 0.001
		No	1036	63.5	596	36.5	
	Brush teeth twice or more a day	Yes	1098	63.2	639	36.8	< 0.001
		No	178	39.5	273	60.5	
	Sugary food consumption	Yes	1184	58.7	834	41.3	0.015
		No	96	49.5	98	50.5	
	Sugary drink consumption	Yes	1117	60.4	731	39.6	< 0.001
		No	162	45.6	193	54.4	
Oral disease	Periodontal health	Yes	546	65.9	282	34.1	< 0.001
		No	722	53.0	639	47.0	
	DMFT	0	107	66.9	53	33.1	< 0.001
		1–5	447	63.3	259	36.7	
		6–12	532	59.0	370	41.0	
		> 12	123	37.5	205	62.5	
	Acid erosion	Yes	49	53.4	217	46.6	0.027
		No	1039	59.2	715	40.8	
	Malocclusion	Yes	179	52.3	163	47.7	0.024
		No	1111	58.9	774	41.1	

objective, are combined within their perceptual framework[18]. SPOH may be an appropriate indicator for use in diverse sociocultural contexts[19]. Some findings have indicated that oral health perception may be a useful measure in public health due to its relationship with health determinants and health service use[20].

We asked subjects to evaluate their own oral and general health condition with a single intuitive question. The proportion of respondents with good SPOH was 43.4%. This was significantly lower than reported in studies conducted in Yemen (51%)[16], Canada (81.5%)[21], Nigeria (58.3%)[22] and Brazil (59.7%)[23]. The proportion of participants who considered they had good SPGH was 57.9%, a significantly higher result than that for SPOH, and higher than in Japan (36.9%)[24] but lower than in the USA (83.0%)[25]. The diversity of findings could be explained by differences in age, health knowledge and awareness, the quality of health services in different countries and personality differences in ethnic groups in different countries. The

Table 4 Correlation between responses concerning SPOH and SPGH.

		SPGH				*P* value	Spearman correlation
		Good		Not good			
		n	%	n	%		
SPOH	Good	881	91.5	82	8.5	< 0.001	0.593
	Not good	408	32.4	850	67.6		

Table 5 Ordinal regression for the effect of study variables on SPOH status.

Variable		OR	OR (95% CI)		*P* value
			Lower	Upper	
Age, y	18–24	1 (reference)	NA	NA	
	25–34	0.938	0.717	1.228	0.644
	35–44	0.665	0.489	0.905	0.009
	45–54	0.636	0.444	0.911	0.014
	> 55	0.56	0.377	0.832	0.004
Dental prosthesis	Yes	0.494	0.305	0.800	0.003
	No	1 (reference)	NA	NA	NA
Smoking	Yes	0.597	0.472	0.756	< 0.001
	No	1 (reference)	NA	NA	NA
Brush teeth twice or more a day	Yes	1.717	1.329	2.219	< 0.001
	No	1 (reference)	NA	NA	NA
Sugary drink consumption	Yes	1.592	1.198	2.114	0.001
	No	1 (reference)	NA	NA	NA
Periodontal health	Yes	1.674	1.366	2.051	< 0.001
	No	1 (reference)	NA	NA	NA
Does patient have any other oral diseases – malocclusion?	Yes	0.730	0.557	0.955	0.022
	No	1 (reference)	NA	NA	NA
DMFT	0	1.864	1.171	2.967	0.009
	1–5	1.703	1.207	2.403	0.002
	6–12	1.380	0.996	1.913	0.053
	> 12	1 (reference)	NA	NA	NA

Table 6 Ordinal regression for the effect of study variables on SPGH status.

Variable		OR	OR (95% CI)		*P* value
			Lower	Upper	
Age, y	18–24	1 (reference)	NA	NA	
	25–34	0.979	0.734	1.305	0.884
	35–44	0.670	0.488	0.920	0.013
	45–54	0.958	0.667	1.376	0.817
	> 55	0.918	0.662	1.355	0.666
Education	Primary education or less	1 (reference)	NA	NA	NA
	Secondary education	1.706	1.032	2.8200	0.037
	Bachelor's degree or higher	2.535	1.511	4.2510	< 0.001
Dental prosthesis	Yes	0.647	0.429	0.976	0.036
	No	1 (reference)	NA	NA	NA
Smoking	Yes	0.571	0.455	0.715	< 0.001
	No	1 (reference)	NA	NA	NA
Brush teeth twice or more a day	Yes	1.829	1.431	2.334	< 0.001
	No	1 (reference)	NA	NA	NA
Sugary drink consumption	Yes	1.536	1.171	2.020	0.002
	No	1 (reference)	NA	NA	NA
Periodontal health	Yes	1.253	1.015	1.547	0.036
	No	1 (reference)	NA	NA	NA
Does patient have any other oral diseases – malocclusion?	Yes	0.757	0.583	0.984	0.037
	No	1 (reference)	NA	NA	NA
DMFT	0	1.836	1.154	2.923	0.010
	1–5	1.579	1.140	2.186	0.006
	6–12	1.602	1.186	2.164	0.002
	> 12	1 (reference)	NA	NA	NA

results obtained showed that SPGH is at a slightly better level than SPOH, but still requires attention. The results suggest that more attention should be paid to oral health by improving people's oral health knowledge and behaviour through relevant policies and social publicity; in this way, we can also improve oral health.

In the multivariate analysis, subjects who smoked or used to smoke had bad SPOH and SPGH. This may be due to the fact that smoking is prone to altering oral, lung and intestinal microbiota, leading to various general diseases like periodontitis, asthma, chronic obstructive pulmonary disease, Crohn's disease, ulcerative colitis and cancer[26]. Good SPOH and SPGH status were also associated with the oral health behaviour of brushing the teeth twice or more times a day. The oral environment is a highly complex microenvironment in which a wide variety of microorganisms coexist[27]. Tooth brushing may help to maintain the oral flora balance. Some bacteria in the oral microbiota are directly associated with respiratory pathogens that cause pneumonia[28], and general inflammation can also be caused by the oral pathogen soluble antigen[29]. It was reported that some links between oral diseases and general diseases may be due to unhealthy behaviours that are harmful to both oral and general health30, for example smoking. Furthermore, studies supported that the areas in which oral disorders had the most significant impact were tooth brushing and cleaning[31,32]. Subjects without dentures were found to have better SPOH and SPGH; denture wear may be associated with previous oral disease, multiple dentition defects or full edentulism and the discomfort of wearing removable dentures. Furthermore, we found that periodontal disease, caries and malocclusion have an effect on SPOH and SPGH, which is consistent with the findings of Arantes and Frazão[19]. This result indicates that SPOH can partially reflect actual oral health status, so it can be considered as a more effective oral health evaluation index when assessing people's oral health status. Oral disease–related variables have an impact on SPGH status, and this also indicates that oral disease is partially associated with general health. This may be because periodontitis is a risk factor in the complex pathogenesis of diabetes, cardiovascular disease, kidney disease and recurrent pneumonia[33]. Caries lesions and periodontal disease can also cause some pain and tooth loss, which can affect chewing function. Oral health can impact food choices and have a negative effect on food intake, resulting in poor nutritional conditions and leading to chronic systemic disease, which in turn affects oral health[34]. Malocclusion can affect the aesthetic appearance of the face. Dental crowding in malocclusion can easily lead to plaque retention and can affect tooth cleaning, leading to caries lesions and periodontal disease.

The results showed a significant positive correlation between SPOH and SPGH. A study confirmed that oral health is an integral part of systemic health, and it is certain that oral health is part of general health[35]. We found many common risk factors related to oral health between SPOH and SPGH. This suggests that to prevent and control oral diseases and systemic diseases, we must not ignore the role of oral health–related factors and that there should not be just one method for prevention and treatment of oral or systemic diseases, but rather multidisciplinary cooperation, with oral health education included in general disease prevention and disease control projects.

Conclusion

SPOH better reflects actual oral health status and can be used as a regular indicator to predict oral health status. SPOH and SPGH have many common risk factors related to oral health, so more attention must be paid to oral health in order to promote general health.

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Conflicts of interest

The authors declare no conflicts of interest related to this study.

Author contribution

Drs Yi Zhen YU, Shuo DU, Min DING and Zhi Ying CUI analysed the data; Dr Yi Zhen YU drafted the paper; Drs Yan Si and Yi Liu conceived the programme of research, checked the analysis and critically revised the manuscript. All authors approved the final manuscript for submission.

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