

# Associations between self-rated oral health, subjective oral conditions, oral health behaviours and oral health-related quality of life among college students: A study using structural equation modelling

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Research Article

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# Abstract

**Background:** This study aimed to evaluate the relationship between self-rated oral health, subjective oral conditions, oral health behaviours, and oral health-related quality of life (OHRQoL) in Chinese college students.

**Methods:** We conducted an online cross-sectional survey inviting college students from eastern China. A total of 1,708 participants were included. We constructed a structural equation model to explain and assess the associations among self-rated oral health, subjective oral conditions, oral health behaviours, and OHRQoL.

**Results:** Self-rated oral health had a direct positive effect on subjective oral conditions and OHRQoL. Oral health behaviours had a direct negative effect on subjective oral conditions and OHRQoL, while oral health behaviours had a direct negative effect on tooth condition perception and oral health interventions. Subjective oral conditions had a direct positive effect on OHRQoL. There was a positive correlation between oral health behaviours and self-rated oral health. In addition, subjective oral conditions partially mediated both the effect of oral health behaviours on OHRQoL and the effect of self-rated oral health on OHRQoL.

**Conclusion:** There were influential associations between self-rated oral health, subjective oral conditions, oral health behaviours, and OHRQoL among college students in eastern China.

## Background

Oral health is one of the important components of overall health, and the quality of life will also be adversely affected by poor oral health [1]. Therefore, improving oral health plays a significant role in enhancing the overall quality of life of the population [1]. College students represent a highly educated population. Their oral health is more likely to have a greater impact on their lives as well as on their social development [2]. Compared to other populations, college students are more prone to be educated about oral prevention and care, and to change poor oral habits [2]. Thus, understanding the oral health of college students is helpful in guiding them to develop good oral preventive and care habits [2].

The oral health-related quality of life (OHRQoL) construct is often used in oral health research to measure the impact of oral disease and oral conditions on patients' general condition and daily behavioural life [3]. The OHRQoL is a multidimensional construct that measures patients' oral health status, functional emotional health, expectations and satisfaction with care, and a subjective assessment of self-awareness [4]. It describes the role of oral disease in an individual's daily life [5]. Measuring a student's OHRQoL is also important for conducting oral health surveys and oral disease prevention [6], as well as for determining the effectiveness of clinical treatment of oral diseases [7]. Today, OHRQoL is also an important component of global oral health programs [4].

Epidemiological studies often use self-rated oral health as an indicator of a subjective experience that has an important impact on people's well-being and quality of life [8-11]. A study by Yamane *et al.* pointed out that 63.2% of Japanese college students were found to have fair or even poor self-rated oral health, and self-rated oral health had a significant impact on OHRQoL [12]. Self-rated oral health reflects an individual's subjective experience of perceptions of physical and mental health, treatment needs, functioning, clinical signs and symptoms of adverse conditions [13]. It is one of the patient's most immediate responses, covering multiple aspects and determinants of oral health [14], and can sometimes even replace clinical disease [14-16]. Conducting a self-rated oral health can help society to plan and monitor health services as well as health promotion interventions to improve overall health [10,11,14,17-19]. Previous studies have shown that the monitoring of young people's oral health should also include information on testing self-rated oral health [20,21].

The main factors associated with self-rated oral health include clinical examination oral factors as well as subjective oral factors. Clinical examination oral factors included tooth loss, tooth decay, bleeding gums, and dental care, while subjective measures included reported overall health, oral appearance, and dental pain [14]. Subjective oral conditions are primarily derived from individual judgements, that is, an individual's subjective perception of oral conditions [22]. Currently, subjective oral conditions are used more often in dental care to determine the severity of a patient's disease rather than the only traditional objective oral conditions indicators [23]. It has been shown that an individual's subjective feelings have a more significant impact on how they feel about themselves, and it can make a large difference in a patient's mood and condition [24]. A study by Bernabé E *et al.* reported that about a quarter of adolescents would have an impact on their quality of life due to poor oral conditions [25]. The physical and psychological changes of adolescents are quite rapid, and their health problems are gradually shifting from their parents' to their own responsibility [26]. But their oral health awareness is limited [27]. Attention to the subjective oral conditions of college students is of great importance for both their physical and mental development.

Studies has reported that poor oral health behaviours may adversely affect OHRQoL [28,29]. Oral health behaviours include proper brushing, use of fluoride toothpaste, flossing, reducing intake of high-sugar foods, and regular oral examinations. A study by Hsu KJ *et al.* found that oral health behaviours and oral habits affect dental health [30]. Study has pointed out that as college students adjust to a new environment, they will also face greater stress and therefore they tend to neglect oral health care [31]. Thereby, college students may be inattentive to adopt appropriate oral health care behaviours. A study by Crabtree R *et al.* found that proper oral health behaviours among college students were an important factor in overall health and well-being [31]. This may further have an impact on their oral health-related quality of life .

In China, there are few studies on the associations between self-rated oral health, subjective oral conditions, oral health behaviours and OHRQoL. In addition, there are not many studies that combine oral health, personal behaviour, and OHRQoL. Therefore, this study aimed to construct structural equation

modelling (SEM) to explore the complex associations between them. The results of our study will help to intervene and improve the oral health of college students.

## Methods

### Subjects and Design

We conducted a cross-sectional research survey of college students from 22 comprehensive colleges in Anhui Province, China between October 2019 and January 2020. An electronic questionnaire was sent to college students using an online survey. Verbal consent was obtained from all participants and there was no intervention throughout the information filling process. A total of 2,000 e-surveys were sent to these college students via a random sampling method within each college, and total returns were 1,817. The data analysis rejected 109 questionnaires and included a total of 1,708 valid questionnaires, with a response rate of 94.0%. The effective response rate was 85.4%. The exclusion criteria were as follows: (1) questionnaire missing values greater than 10%; (2) reading and comprehension difficulties, and (3) logical inconsistency of answers.

Moreover, our study is based on a cross-section of the population of Anhui province. The sample size was calculated according to the formula  $N = Z^2P(1-P)/d^2$  ( $Z = 1.96$ ,  $P = 60.1\%$ ,  $d = 0.05$ ) [32]. Where  $N$  is the sample size.  $Z$  is the statistic, when the confidence level is 95%,  $Z = 1.96$ .  $P$  was calculated using the oral health knowledge rate of 60.1% of the population from a previous survey [33]. And considering 20% invalid response rate. The minimum sample size obtained was 441. We exceeded the minimum required sample size to ensure the credibility of our results.

### Ethical Approval

The study was ethically approved by the Medical Ethics Committee of Bengbu Medical College, China (No. 2019-062). Prior to the start of the study, the details of the study and the processing of the results were explained to college students. Students who did not want to participate in the study could refuse to fill out the questionnaire, and all participants did so voluntarily.

### Hypotheses

According to our hypotheses (Figure 1), self-rated oral health and oral health behaviours have a positive effect on subjective oral conditions and OHRQoL. Oral health behaviours are also positively related to self-rated oral health. Also, subjective oral conditions are positively related to OHRQoL.

### Survey Instruments

We designed our questionnaire based on reference literatures. The questionnaire included the following items: demographic characteristics, self-rated oral health, subjective oral conditions, oral health behaviours, and OHRQoL.

The first part is self-rated oral health, which consists of 5 questions. This part is divided into three categories. The first category is the oral health perception, and use the question 'What is your judgment about your oral health?'. The answer used the 5-point Likert scale to calculate the score, '0 = very good', '1 = good', '2 = fair', '3 = poor' and '4 = very poor' [11]. Use 'What is your assessment of your tooth health' to determine the second category of tooth condition perception. The answer uses the 5-point Likert scale to calculate the score, '1 = excellent', '2 = very good', '3 = good', '4 = average', '5 = poor'. The third category is oral health interventions. The questions include 'When did you last visit the dentist (stomatologist)?'. The response options were '1 = never', '2 = last month', '3 = last three months', '4 = last six months' and '5 = one year ago'. 'What was your reason for going to the dentist?' and 'Have you received any oral health education (health education seminars) ?'. The response options are: '1 = yes' and '2 = no'.

The subjective oral conditions were evaluated using 9 questions such as 'Have you ever had bleeding gums?'; 'Have you ever had tooth pain?'; 'Did you ever feel TMJ pain when opening your mouth or chewing food?'. The answer uses the 3-point Likert scale to calculate the score, '0 = never', '1 = occasionally', '2 = frequently'.

Oral health behaviours include 9 questions. Participants filled in the questions according to their actual situation. This part is divided into four categories. The first category is brushing. The questions include 'Do you brush your teeth  $\geq 2$  times a day?' (B1); 'Do you brush your teeth every time  $\geq 3$  minutes?' (B2); 'Do you change a toothbrush every three months?' (B3). The second category is tooth cleaning. The questions include 'Do you often use dental floss (or interdental brushes) to help clean interdental spaces?' (C1) [34]; 'Do you often gargle after meals?' (C2); 'Do you clean your teeth regularly (teeth washing)?' (C3); 'Is your brushing method the 'horizontal tremor brushing method' recommended by the Chinese Stomatological Association?' (C4). The third category is the oral health checkup. The question is 'Do you regularly perform oral health checkups?' [34]. The fourth category is the use of fluoride toothpaste, the question is 'Do you often use fluoride toothpaste?' [20]. The option scores of the questions are '1 = Yes' and '0 = No'.

The fourth part is OHRQoL. The Chinese version of Oral Health Impact Profile (OHIP)-14 was selected to evaluate OHRQoL. OHIP scores were significantly correlated with life satisfaction [6]. Response options are '4 = often', '3 = fairly often', '2 = occasionally', '1 = hardly ever', and '0 = never' [35]. The higher the OHIP-14 score, the worse the OHRQoL is influenced by the oral condition.

The overall Cronbach's  $\alpha$  for the questionnaire is  $\alpha = 0.903$ . The internal consistency of this questionnaire is good.

## **Statistical analysis**

We used IBM® SPSS® Statistics 20.0 and IBM® SPSS® Amos™ 24.0 for data analysis.

We used frequency, percentage and mean  $\pm$  standard deviation to describe the demographic characteristics of participants. We tested the appropriateness of the scale using the KMO measure and

the Bartlett spherical test. The KMO coefficient for this questionnaire was 0.927 and the  $p$ -value of Bartlett's test was  $< 0.001$ . We used exploratory factor analysis (EFA) to examine the degree of association between questions. A project analysis was carried out to test the degree of differentiation of the questions on a 27% scale.

The associations that existed between self-rated oral health, subjective oral conditions, oral health behaviours, and OHRQoL were analyzed by constructing a SEM. Before constructing the SEM, we first performed a confirmatory factor analysis (CFA) to assess whether the factor structure chosen based on our study was also acceptable in these data or whether it should be modified [36]. When constructing the SEM, each observed variable is imported and calculated as a mean value. We use the Bootstrap method [35,37] to verify whether there are mediating effects between the variables of interest in the model. We bootstrapped 5000 samples from the raw data ( $n = 1,708$ ) by putting back a random sample. The confidence interval (CI) was 95% for the direct and indirect effects of each of the suggested mediating variables beyond zero. Using the skewness–kurtosis test to check the normality of the observed variables [38].

The model fit was evaluated using maximum likelihood estimate (MLE), chi-square ( $\chi^2$ ) values, degree of freedom (DF), goodness of fit index (GFI), comparative fit index (CFI), normed fit index (NFI), incremental fit index (IFI), adjusted goodness of fit index (AGFI), root mean square error of approximation (RMSEA) and other indicators [36,39]. For CFI, GFI, NFI, IFI and AGFI, a fit index above 0.90 (preferably above 0.95) and an RMSEA less than 0.05, indicating that the model fits well [39-41]. Regression coefficients were used with a significance level of  $p < 0.05$  [12].

## Results

### Demographic data

We analyzed a total of 1,708 data from college students, aged  $22.0 \pm 4.3$  years. The majority of them were female (57.4%), medical non-oral majors (54.3%), junior (27.5%), and with an annual household income less than ¥50,000 (42.7%). Table 1 shows the characteristics of the respondents.

**Table 1** Characteristics of the Participants ( $n = 1,708$ )

Characteristics		Frequency (n)	Percentage (%)
Age			22.0 ± 4.3 <sup>a</sup>
Gender	Male	727	42.6
	Female	981	57.4
Major	Stomatology major	273	16.0
	Medical non-oral specialty	928	54.3
	Non-medical majors	507	29.7
Grade	Freshman	451	26.4
	Sophomore	243	14.2
	Junior	469	27.5
	Senior	202	11.8
	Graduate	171	10.0
	Postgraduate	172	10.1
Annual household income	Less than ¥50,000	729	42.7
	¥50, 000 to ¥120,000	705	41.3
	More than ¥120,000	274	16.0

<sup>a</sup> mean ± standard deviation

### Descriptive analysis for self-rated oral health, subjective oral conditions, oral health behaviours and OHRQoL

The overall rating for self-rated oral health ranged from 06–20, with an average rating of 11.29 ± 3.26. Oral health perception scored highest on its three subscales (2.95 ± 0.73), followed by oral health interventions (2.15 ± 0.88) and finally, tooth condition perception (1.89 ± 1.20). Subjective oral conditions of the survey respondents ranged from 0–19, and the mean score was 4.33 ± 3.30. Overall oral health behaviours ranged from 1–9 with a mean rating of 4.02 ± 2.01. Most students could brush their teeth ≥ 2 times a day (77.2%), for ≥ 3 minutes each time (59.9%), and change their toothbrush every three months (81.9%). About half of the students could rinse their mouth after meals (41.9%) and brush with fluoride toothpaste (44.6%). In contrast, fewer students flossed their teeth regularly (22.2%), scaled their teeth regularly (18.2%), brushed their teeth using the horizontal vibration brushing method recommended by the Chinese Stomatological Association (39.8%), or had regular oral health checkups (15.6%). OHIP-14 scores range from 0 to 54 with an average score of 13.17 ± 11.83.

### Structural equation model

Table 2 shows the normality results for the latent variables. All variables have the absolute value of skewness < 3 and the absolute value of kurtosis < 8, indicating that the distribution of the sample in the variables is consistent with a normal distribution. The value of chi-square is equal to 54.809, degrees of freedom is equal to 21, so chi-square/degrees of freedom ( $\chi^2/df$ ) = 2.610 (< 3). And  $p < 0.001$ , indicating that the model is significant. The CFI = 0.979, GFI = 0.993, NFI = 0.967, IFI = 0.979, AGFI = 0.985, RFI = 0.943, PNFI = 0.564, PCFI = 0.571, TLI = 0.964 and RMSEA = 0.031, indicating that the model data fit well [12].

**Table 2** Descriptive statistics for self-rated oral health, oral health behaviours, subjective oral conditions and OHRQoL

	N(%) (Score = 1)	Mean ± SD	Range	Median	Skewness	Kurtosis
		11.29 ± 3.26	6.00- 20.00	12.00	—	—
Oral health perception		2.95 ± 0.73	1.00- 5.00	3.00	0.261	-1.211
Tooth condition perception		1.89 ± 1.20	1.00- 5.00	1.00	1.234	0.511
Oral health interventions		2.15 ± 0.88	1.00- 4.00	2.33	-0.362	1.519
		4.02 ± 2.01	1.00- 9.00	4.00	—	—
Brushing		0.73 ± 0.27	0.00- 1.00	0.67	-0.637	-0.538
	B1 1319 (77.2)					
	B2 1024 (59.9)					
	B3 1399 (81.9)					
Tooth cleaning		0.31 ± 0.31	0.00- 1.00	0.25	0.870	-0.179
	C1 380 (22.2)					
	C2 716 (41.9)					
	C3 311 (18.2)					
	C4 681 (39.8)					
Oral health checkup	268 (15.6)	0.16 ± 0.36	0.00- 1.00	0.00	1.887	1.559
Use of fluoride toothpaste	762 (44.6)	0.45 ± 0.50	0.00- 1.00	0.00	0.217	-1.953
		4.33 ± 3.30	0.00- 19.00	4.00	1.209	1.982
Impact		13.17 ± 11.83	0.00- 54.00	12.00	0.787	-0.044

**Note.** SD: Standard Deviation

### Correlation analysis between variables

Figure 2 shows the standardized estimated parameters of the final structural model. Table 3 shows the results of the correlations between the variables. All paths are significant ( $p < 0.001$ ). The model showed that (1) there was a positive correlation between oral health behaviours and self-rated oral health ( $\beta =$

-0.326). (2) Oral health behaviours had a positive effect on oral health interventions ( $\beta = 0.177$ ). (3) Subjective oral conditions had a direct positive effect on OHRQoL ( $\beta = 0.346$ ). (4) Self-rated oral health had a positive effect on subjective oral conditions ( $\beta = 0.442$ ). (5) Self-rated oral health had a positive effect on OHRQoL ( $\beta = 0.191$ ). (6) Oral health behaviours had a negative effect on OHRQoL ( $\beta = 0.119$ ). And (7) oral health behaviours had a negative effect on subjective oral conditions ( $\beta = 0.143$ ) as well as tooth condition perception ( $\beta = 0.595$ ).

**Table 3** Correlation analysis between variables

Model paths		Standardized estimate	S.E.	C.R.	<i>P</i>
Subjective oral conditions	← Oral health behaviours	0.143	0.503	4.385	***
Subjective oral conditions	← Self-rated oral health	0.442	2.674	4.237	***
Use of fluoride toothpaste	← Oral health behaviours	0.323	0.070	10.710	***
OHRQoL	← Subjective oral conditions	0.346	0.093	13.276	***
OHRQoL	← Oral health behaviours	0.119	1.637	4.009	***
Tooth condition perception	← Self-rated oral health	0.595	1.244	4.458	***
Oral health interventions	← Self-rated oral health	0.146	—	—	—
Oral health interventions	← Oral health behaviours	0.177	0.130	5.594	***
OHRQoL	← Self-rated oral health	0.191	5.107	3.431	***
Brushing	← Oral health behaviours	0.285	0.039	9.247	***
Oral health cleaning	← Oral health behaviours	0.801	0.088	13.112	***
Oral health checkup	← Oral health behaviours	0.591	—	—	—
Oral health perception	← Self-rated oral health	0.715	0.962	4.209	***
Tooth condition perception	← Oral health behaviours	0.231	0.199	6.483	***
Oral health behaviours	↔ Self-rated oral health	-0.326	0.003	-3.582	***

\*\*\*  $P < 0.001$

We used the Bootstrap method to test the mediating effects of the model with a bias correction of 95% CI. The direct and indirect effect results are shown in Table 4. The results showed that (1) oral health behaviours had a direct positive effect on subjective oral conditions, oral health interventions, and tooth condition perception with values of 0.143, 0.177, and 0.231, respectively. Indicated that oral health behaviours had the greatest effect on tooth condition perception. (2) Self-rated oral health had a direct positive effect on subjective oral conditions with an effect size of 0.442. (3) Subjective oral conditions had a direct positive effect on OHRQoL with an effect value of 0.346. (4) Oral health behaviours had a direct effect on OHRQoL with an effect value of 0.119 and an indirect effect on OHRQoL with an effect size of 0.05. 95% CI: 0.026-0.077. It was shown that subjective oral conditions play a partial mediating effect in the effect of oral health behaviours on OHRQoL. (5) There was a direct positive effect of self-rated oral health on OHRQoL, with an effect size of 0.191 and an indirect effect value of 0.153, 95% CI: 0.121-0.191. It indicated that subjective oral conditions also played a partial mediating effect in the effect of self-rated oral health on OHRQoL.

**Table 4** Bootstrap analysis of mediating effect significance test for the model

Path	Standardized direct effects	Bias-Corrected 95%CI		Standardized indirect effects	Bias-Corrected 95%CI	
		LLCI	ULCI		LLCI	ULCI
health behaviours → subjective oral conditions	0.143***	0.075	0.212	—	—	—
health behaviours → oral health interventions	0.177***	0.117	0.238	—	—	—
health behaviours → OHRQoL	0.119**	0.056	0.182	0.050***	0.026	0.077
health behaviours → Tooth condition perception	0.231***	0.159	0.309	—	—	—
self-rated oral health → subjective oral conditions	0.442***	0.373	0.510	—	—	—
self-rated oral health → OHRQoL	0.191***	0.118	0.267	0.153***	0.121	0.191
subjective oral conditions → OHRQoL	0.346***	0.288	0.402	—	—	—

All of the direct effects were significant ( $p < 0.01$ ); \*\* $P < 0.01$ ; \*\*\* $P < 0.001$ ; 95%CI: 95% confidence interval; OHRQoL: oral health-related quality of life

## Discussion

This study analyzed the potential associations between self-rated oral health, subjective oral conditions, oral health behaviours, and OHRQoL among college students by constructing SEM. The results showed

that there were influential associations between the variables. To our knowledge, there are few such studies for college students in Anhui Province. Our study aimed to explore in advance the oral health behavioural problems of college students as well as their self-perceptions of oral health to improve OHRQoL and further improve their health status. It is instructive for targeted improvement and prevention of oral health problems among college students, as well as for systematic oral health education.

We found a direct negative relationship between college students' oral health behaviours and their self-rated oral health ( $\beta = -0.326, p < 0.001$ ). According to the questionnaire score design, correct oral health behaviours lead to better self-rated oral health, and good self-rated oral health also promotes the development of correct oral health behaviours. Ueno M *et al.* found that when people become aware of a problem with their oral conditions, it may lead to corresponding health behaviours change, such as visiting the dentist and improving brushing patterns [10]. Meanwhile, when poor oral health behaviours are identified, they can be improved in order to enhance oral health [42]. There are similar to our findings. Oral health behaviours are important determinants of oral health, including regular brushing with fluoride toothpaste, checkups, and preventive treatments (scaling, sealants, and fluoride treatments) [43]. Because previous study has generally recognized health as a subjective state, self-rated health has been used more in dental epidemiology and health services research [44]. Health education and the development of lifelong health behaviours by making the most of the golden age of college [31]. It is possible to fundamentally improve students' self-rated oral health.

The results of the study showed that the better the oral health behaviours, the more oral health interventions were implemented by the students. This is similar to the results of the previous study [45,46]. Oral interventions included seeing a dentist and receiving education about oral health. Study has shown that, oral health behaviours such as annual dental checkups and brushing after every meal are essential to reduce plaque and tartar [47]. Nakre PD *et al.* found that oral health education had a significant effect on improving people's oral health behaviours [48]. Therefore, regular diagnosis of dental disease and dental checkups are more likely to help improve the condition of mouth as well as overall health [49,50]. College students are mainly 17 to 25 years old and are in the transitional stage of life, which is an important period for the formation of health concepts and behaviours [51]. Hence, during this period, it is important to provide the necessary oral health interventions and dental education to make them aware of the importance of oral health in order to maintain their oral health in the future.

In addition, the results indicated that when the subjective oral conditions are worse, the poorer the OHRQoL of college students. This finding is also supported by similar studies. A study of Japanese college students by Yamane *et al.* found significant effects of oral diseases such as oral pain, malocclusion, dental caries, and TMD on OHRQoL [12]. When people suffer from toothache, they inevitably experience unbearable pain, which has a negative impact on their daily work and quality of life [52]. It has been found that subjective health condition assessments reflect more accurately on a patient's quality of life than clinical assessments [53]. Thus, when oral diseases are reduced and oral health is improved, it may benefit mental health and quality of life will improve accordingly [54]. We encourage

college students to have regular oral health examinations and to treat oral diseases as soon as possible when they occur so that their quality of life is not compromised.

Our study demonstrated that the better the self-rated oral health of college students, the better their subjective oral conditions as well as OHRQoL. Rui Arantes *et al.* found that symptoms of oral diseases such as toothache play an important role in oral health self-assessment [13]. Our finding was similar to the result of previous study in Japan, which showed that self-rated oral health had positive correlations with subjective chewing ability as well as OHRQoL [12]. The perception of oral health was strongly related to their utilization of oral health services and whether they were aware that they had oral diseases. In other words, subjective oral disease conditions also influences college students' perceptions of their oral health [55]. On the other hand, perceived oral health reflects an individual's subjective impressions, including not only health status, but also satisfaction with the aesthetic condition and of oral health [56]. When college students have good oral and dental health, they also have clean breath and beautiful smiles, and they make a better impression when interacting with their peers, which is important for today's adolescents [31]. This can be interpreted to mean that when the oral and tooth conditions are good, college students also develop enough self-confidence in themselves to perform better in all aspects of lives, thus contributing to their well-being and quality of life.

The path from oral health behaviours to OHRQoL did not fit our expected model ( $\beta = 0.119, p < 0.001$ ). The results indicated that oral health behaviours have a negative impact on OHRQoL. However, Vigu AL *et al.*'s study of Romanian college students found a association between oral behaviours and OHRQoL [57]. A study by Broadbent *et al.* found that oral health behaviours in adults have a significant impact on symptoms such as dental caries or tooth loss, thus further influencing OHRQoL [29]. The reason for this result, we speculate, may be related to the way the survey was a questionnaire distribution, the recall bias of college students, or to the fact that there are few young college students with severe oral diseases.

Our results suggest that when college students perform better oral health behaviours, they may have worse subjective oral conditions and poorer tooth condition perception. This differs from previous finding [58]. Lalani A *et al.*'s oral health survey of dental students found that oral health behaviours were significantly and negatively associated with plaque and gingivitis [59]. The reason for this phenomenon can be explained by the fact that a small percentage (14.8%) of the population in our survey were dental students, and the rest of the college students may not have really learned the correct brushing or oral cleaning methods, which did not play a significant role in improving their oral health. They felt overly good about their oral health behaviours, but the actual subjective oral and tooth conditions were not satisfactory. This results in college students' oral health behaviours negatively impacting subjective oral and tooth status. It has been shown that people who do not have expertise have a poorer grasp of oral health behaviours than professional dentists, and their periodontal condition is worse as a result [60].

Notably in our results, subjective oral conditions play a partial mediating role in both the effect of oral health behaviours on OHRQoL and the effect of self-rated oral health on OHRQoL. This is similar to previous studies [12]. It could indicate that the impact of subjective oral conditions on the quality of life

of college students cannot be ignored. Therefore, it can be assumed that the subjective oral conditions are a prerequisite for OHRQoL. In addition, oral health behaviours had the greatest impact on tooth condition perception. Therefore, improving oral health behaviours may be the most effective in changing the tooth condition of college students.

## **Limitations**

Our study has some limitations. First, our study was only conducted among colleges in Anhui Province, which had a limited representative population and cannot be generalized to college students nationwide. Second, our data were obtained by distributing questionnaires, which were subjectively reported by college students, and the lack of clinical examination made it impossible to avoid recall bias and over- or under-evaluation by college students. Third, our survey was a cross-sectional study, and it was not possible to infer causal associations between variables. Later we will extend the study to longitudinal sections. In addition, the influence of other factors (e.g. gender, age) on each variable may have been overlooked.

## **Conclusion**

The self-rated oral health was well in this group of Chinese college students, and some oral health behaviours were also well done, but the subjective oral conditions were not very good. In addition, we found a positive correlation between oral health behaviours and self-rated oral health. Self-rated oral health had a positive effect on subjective oral conditions and OHRQoL. Subjective oral conditions had a direct positive effect on OHRQoL. Oral health behaviours had a negative effect on subjective oral conditions, tooth condition perception and OHRQoL. Oral health behaviours had a positive effect on oral health interventions. Furthermore, subjective oral conditions play a partial mediating role in both the effect of oral health behaviours on OHRQoL and the effect of self-rated oral health on OHRQoL. Further in-depth studies are needed to confirm these results.

## **List Of Abbreviations**

OHRQoL: oral health-related quality of life; OHIP: Oral Health Impact Profile; SEM: structural equation modelling; MLE: maximum likelihood estimate; EFA: exploratory factor analysis; CFA: confirmatory factor analysis; CI: confidence interval; DF: degree of freedom; GFI: goodness of fit index; CFI: comparative fit index; NFI: normed fit index; IFI: incremental fit index; AGFI: adjusted goodness of fit index; RMSEA: root mean square error of approximation

## **Declarations**

### **Ethics approval and consent to participate**

The protocol of this study was approved by the Medical Ethics Committee of Bengbu Medical College, China (project code 2019-062). All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Before data collection, all participants read the consent information, and provided verbal informed consents by clicking "Continue" to take this online survey. The informed consent protocol was approved by the Medical Ethics Committee of Bengbu Medical College, China.

### **Consent for publication**

Not applicable.

### **Availability of data and materials**

The datasets used and/or analysed during the current study were available from the corresponding author on reasonable request.

### **Competing interests**

The authors declare that they have no competing interests.

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### **Authors' contributions**

SHZ and SKL gave substantial contributions to conception and design of this study. SHZ made critical revisions of the manuscript and supervised the whole process. NY performed the statistical analysis and drafted the initial manuscript. SGZ, NTJ, TTH, WD, WZ, HYZ, YYZ, WHL, HG SHZ and SKL all collected the data. All authors have read and approved the final manuscript.

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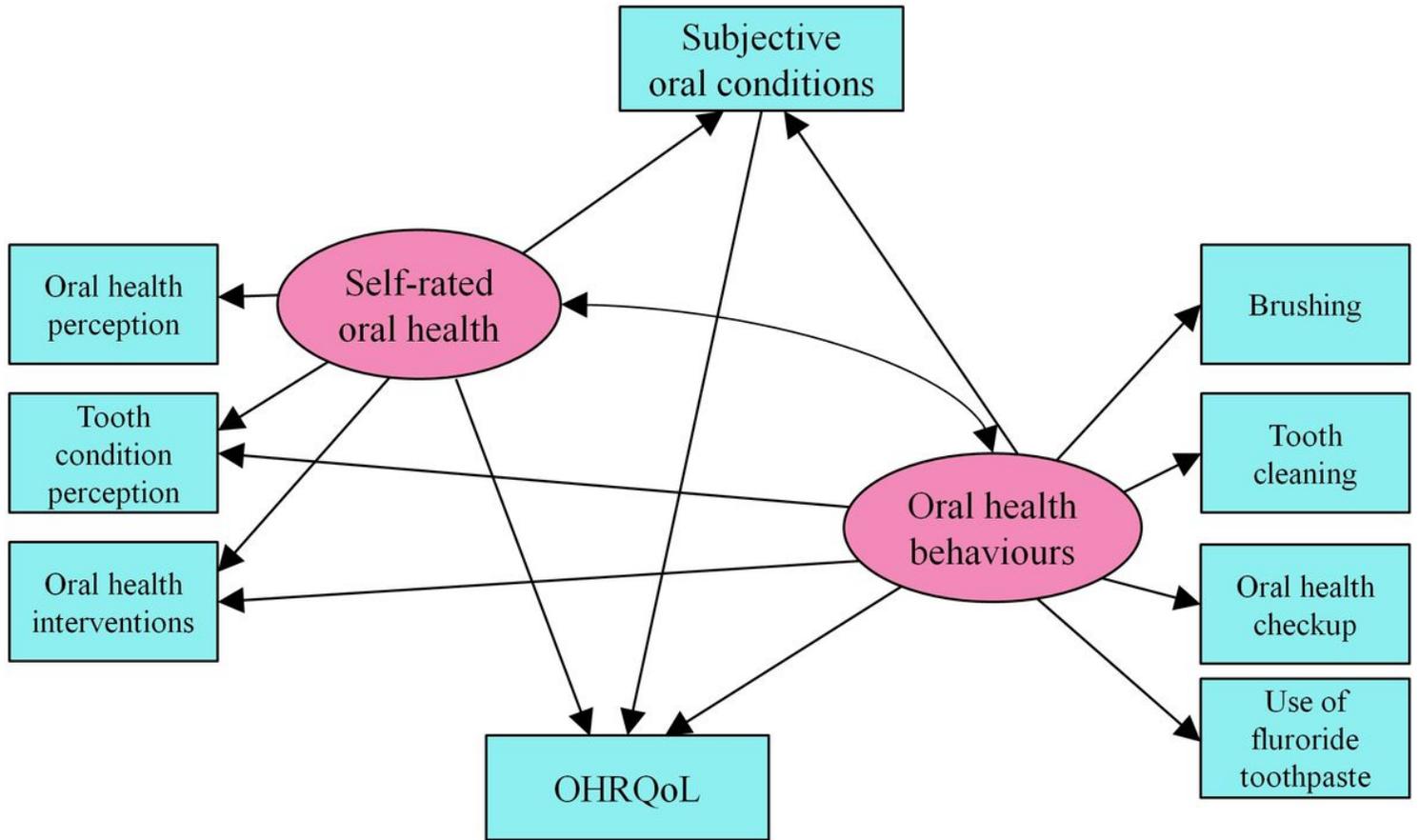
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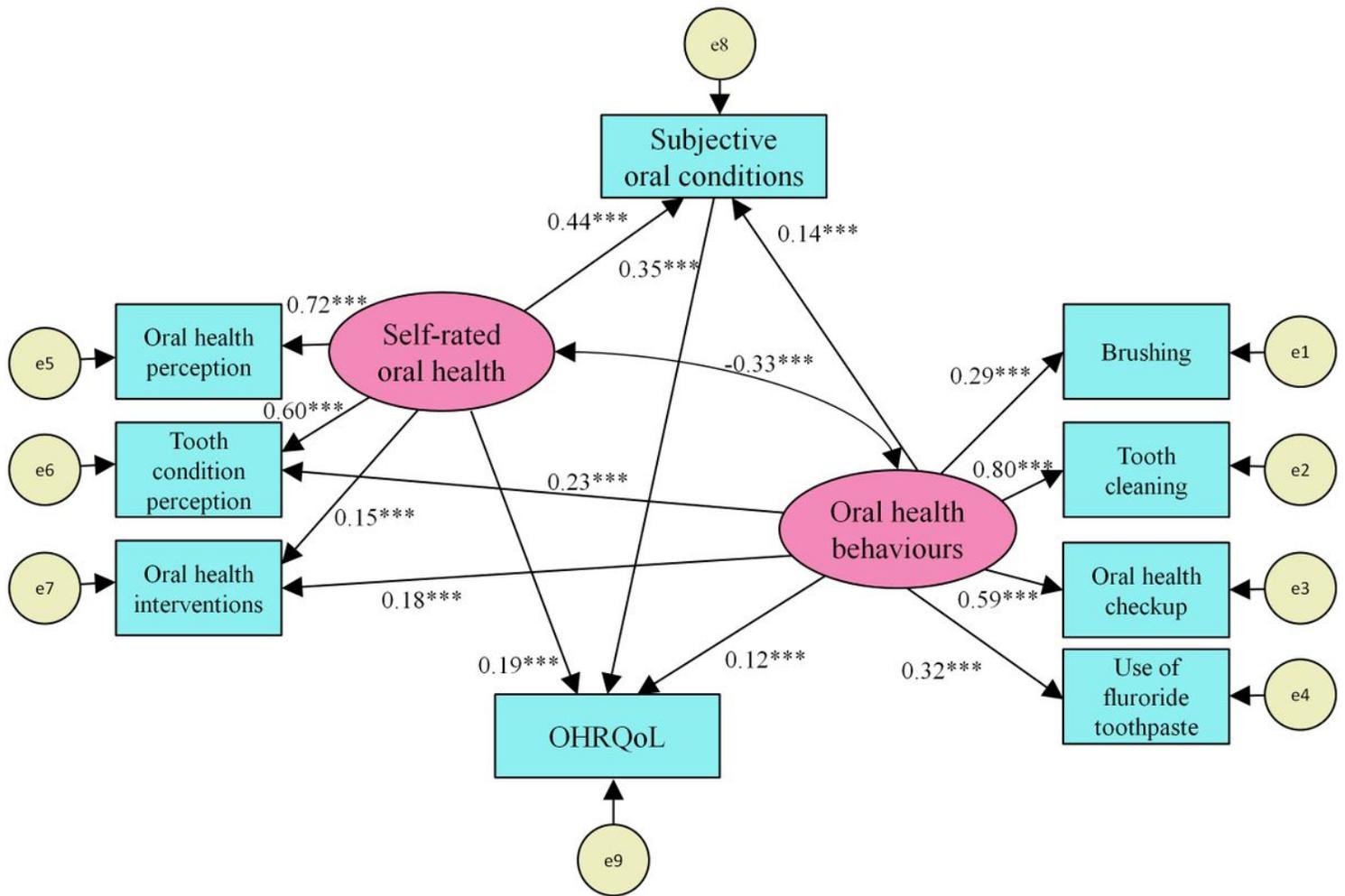
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# Figures



**Figure 1**

Conceptual model with the hypotheses. Rectangles show observed variables, ellipses indicate potential variables, and circles represent residual terms. OHRQoL: oral health-related quality of life



**Figure 2**

The final SEM. Rectangles show observed variables, ellipses indicate potential variables, and circles represent residual terms. The values of single-headed arrows represent the standardized coefficients. All pathways are significant ( $p < 0.001$ ). OHRQoL: oral health-related quality of life