




ORIGINAL RESEARCH

Orthodontic retreatment need and related self-perceived factors among contemporary college freshmen in China

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Abstract

Given that an increasing number of patients who received orthodontic treatment during their childhood or adolescence are seeking retreatment in contemporary China, it is of great necessity to comprehensively understand their motivations. A valid and reliable self-designed questionnaire, based on the Index of complexity, outcome and need (ICON), was distributed online to college freshmen who received orthodontic treatment during their childhood or adolescence. After collecting their basic information and orthodontic retreatment needs data from the survey, the participants' general self-perception of front facial appearance, lateral facial appearance and tooth alignment, as well as their self-perceived dental alignment, occlusal status, oral function and psychological status, were assessed. Correlation analysis, Chi-square test, Kruskal-Wallis test and logistic regression were performed. Reliability was evaluated for 20 paired questionnaires, and all questions were found to be reliable (intraclass correlation coefficient, >0.70). Among the 1609 participants with a history of orthodontic treatment, 45.56% were males and 54.44% were females. Their mean age was 18.48 ± 0.91 years. Our results showed that self-perceived front facial appearance, lateral facial profile, tooth alignment, occlusal status, oral function and psychological status were significantly correlated with orthodontic retreatment needs. Both appearance and psychological status affected their self-perceived dental alignment and occlusal status. In conclusion, patients who received orthodontic treatment during their childhood or adolescence in contemporary China seek orthodontic retreatment because they desire better aesthetics of their front facial appearance and tooth alignment, especially the anterior region of the tooth, the lower part of the face and a decent pronunciation. Additionally, psychological concerns should be viewed as an urge, while intraoral factors should be viewed as the foundation during future clinical practice regarding orthodontic retreatment in this age group.

Keywords

Contemporary China; College freshmen; Children; Adolescent; Orthodontic retreatment; Survey

1. Introduction

The pursuit of beauty and internal satisfaction of Chinese residents have been well-documented in the past decades, most notably the need for oral and maxillofacial esthetics and functional improvement. As orthodontic treatment is becoming increasingly popular, various age groups of patients (from very young to old), especially adolescents, are undergoing orthodontic treatment. Nevertheless, the socioeconomic development trajectories of China have led to rapid but uneven development and resource distribution of orthodontics. Due to the mismatch between people's perception of orthodontic treatment outcomes and local orthodontic medical resources, the results of orthodontic treatment are often not quite opti-

mistic, often resulting in patient dissatisfaction [1, 2]. Additionally, varying reasons were found in the growing proportion of orthodontic retreated patients [3]. Hence, orthodontic retreatment has become a hot topic for both orthodontists and patients. As most published studies have mainly focused on patients who underwent their first orthodontic treatment [4–7], studies regarding retreatment have been limited. A study which investigated 88 retreated patients in the Netherlands reported that these patients had a good perception of dental aesthetics and called for improvement of dental irregularity, prominent upper anterior teeth and undesirable facial profiles [7]. Another survey conducted in Australia in 2020 regarding adult patients seeking first treatment and retreatment found that both groups' profiles were remarkably similar, and aesthetic

concerns were the most prominent features between them [4]. Our previous study also showed that the proportion of people actually needing retreatment was 60.10% [5]. Nevertheless, there are still limited reports on orthodontic retreatment in China.

Adolescents comprise a major portion of patients who usually undergo first orthodontic treatment. For patients who have received orthodontic treatment during adolescence, maturation changes and dental development may also lead to self-perceived needs for retreatment [4]. Maturation often causes minor tooth movements away from a perfect occlusion due to posttreatment growth [4, 8]. Dental development is associated with the craniofacial complex's bimaxillary growth, which undergoes a rapid remodeling process from 3 to 18 years of age [9]. Moreover, poor retention compliance among children and adolescent are also related to original orthodontic treatment failure [4]. Given that the first orthodontic treatment is usually finished before entering college, it would be of great significance to understand the first orthodontic treatment outcomes during childhood and adolescence, together with retreatment needs, in college freshmen. Besides, considering that college freshmen tend to come from different regions of China, a survey targeting this population could be beneficial to produce more generalizable results regarding orthodontic treatment during childhood and adolescence in China.

Hence, a survey focusing on the orthodontic retreatment needs of contemporary Chinese freshmen was conducted to understand motivation factors regarding self-perceived facial appearance, dental alignment and occlusal status, oral function and psychological status of patients who received their first orthodontic treatment during childhood and adolescence could provide important referencing information for clinical practice and further studies.

2. Materials and methods

An appropriately modified questionnaire was designed based on the Index of complexity, outcome and need (ICON), and a pilot study was undertaken to establish its reliability. Twenty participants were recruited from Sichuan University and were asked to complete the survey. After a week, each participant completed a second survey. The results from both surveys were compared to assess the reliability of each question. After the survey was determined to be both valid and reliable, the main study began.

The questionnaire comprised four parts. The first part aimed to collect the participants' basic information, including age, gender, orthodontic treatment history and need for orthodontic retreatment. The second part aimed at collecting their personal scores on their general self-evaluation of front facial appearance, lateral profile appearance and tooth alignment in the range of 1–10, which a higher score representing a higher self-evaluation. The third part was based on fourteen questions to understand the dental alignment and occlusal status of the participants at a self-perceived level. As shown in Table 2, general alignment of teeth was conducted using options such as “well”, “not sure”, and “crowded or gapped”. Three questions were designed to determine their local dental conditions, including tooth missing, shifting and losing (3b–

3d). The remaining ten questions were designed to understand occlusion, overbite and overjet. The last part aimed to ask the participants about their dental-related functional and psychological status. Basic functions regarding eating, chewing and normal pronunciation were collected based on options “no”, “not sure” and “yes”. Psychological status, including tooth-cleaning, confidence, speaking loudly and smiling, were also surveyed by “never”, “occasionally”, “sometimes”, “usually” and “always”.

The last two parts were calculated as total scores named “score of self-perceived dental alignment and occlusal status” and “score of oral function and psychological evaluation” for further analysis. The first option of each question in part three was scored as 0 because they all indicated healthy and non-problematic (normal) conditions. The subsequent options, as listed in Table 3, were scored from 1 to 3. Hence, the total score of this part ranged from 0 to 27, whereby a lower score indicated a higher self-perception and better dental condition. A score of 0/1/2 was distributed to options “no”, “not sure” and “yes” of the first two questions of part four, and a score of 1–5 to options from “never” to “always” of the following four questions. As a result, the total score of this part ranged from 4–24, with a lower score indicating better oral function and psychological status.

The questionnaire was distributed mainly among universities in West China, and the original data were collected online through a Web-based survey tool called Sojump. The criteria for respondents of this survey were freshmen who had just entered colleges, regardless of gender and region. The survey data collection started on 27 September 2021, and lasted 2 weeks.

The SPSS statistical software (version 25, IBM, Armonk, NY, USA) was used to collect the original data and perform statistical analyses. The reliability of the questionnaire was assessed using the data from the pilot study to measure intraclass correlation coefficients for each question. Descriptive analyses of the answers to each question were conducted, together with the frequencies of each option. Correlation analysis and the Chi-square test were conducted to analyze the correlation between five scores, gender and need for orthodontic retreatment. The Kruskal-Wallis test was used to analyze the changes in orthodontic retreatment at different scores. Logistic regression was performed to analyze specific questions of the last two parts affecting the need for orthodontic retreatment in more detail. A p -value < 0.05 was considered statistically significant.

3. Results

Data analysis from the pilot study indicated that each question was reliable. The reliability assessment was based on 20 paired questionnaires and all questions were found to be reliable (intraclass correlation coefficient, >0.70). A total of 3336 questionnaires were distributed and collected, showing a 100% answer rate. Among the investigated participants, 1609 had an orthodontic treatment history, and their data were further analyzed to determine the correlation with our study endpoints.

TABLE 1. Basic information regarding age, sex, orthodontic retreatment need and scores of 1609 participants (n = 1609).

							n	%
Sex (n = 1609)							Female	876
							Male	733
	Mean	SD ¹	P ₂₅	P ₅₀	P ₇₅	Range	Notes	
How would you rate your front appearance?	6.46	2.29	5.00	7.00	8.00	1–10	The higher the rating, the higher the self-evaluation	
How would you rate your lateral profile appearance?	6.71	2.26	5.00	7.00	8.00	1–10		
How would you rate the alignment of your tooth?	6.42	2.24	5.00	7.00	8.00	1–10		
Score of self-perceived dental alignment and occlusal status	12.89	4.41	10.00	13.00	16.00	0–27	The lower the rating, the higher the self-evaluation	
Score of oral function and psychological evaluation	14.53	3.94	12.00	15.00	17.00	4–24		

¹SD indicates standard deviation; Age: mean 18.48 years; SD: 0.91 years; range: 16.00–25.00 years.

3.1 Collection of general information

The mean age of all 1609 respondents was 18.48 ± 0.91 years, ranging from 16–25 years (Table 1), comprising 45.56% males and 54.44% females. The mean scores were 6.46 for front facial appearance, 6.71 for lateral profile appearance, and 6.42 for teeth alignment, with the respective quartiles of 5, 7 and 8 for all three questions.

3.2 Self-perceived dental alignment and occlusal status, and oral function and psychology

The details of the 14 questions regarding self-perceived dental alignment and occlusal status are shown in Table 2. The results showed that the mean score of the total objective tooth alignment and function was 12.89 ± 4.41 . The responses to the 6 specific questions regarding oral function and psychology showed that the mean score of the total oral function and psychology score was 14.53 ± 3.94 (Table 3).

3.3 Correlation of each score with retreatment need

Correlation analysis between the five scores revealed no significant correlation between each other (Table 4). No correlation was found between gender, the five scores and retreatment needs, suggesting that these variables did not interfere with each other. However, significant correlations between retreatment needs and all five scores were found.

The Kruskal-Wallis test was used to analyze the relationship between each score and retreatment needs (Table 5). All scores were significantly correlated with retreatment needs ($p < 0.01$). A lower participant's ratings of their front facial appearance and tooth alignment led to a higher retreatment need. Comparatively, a higher rating of their total dental alignment, occlusal status, oral function and psychology indicated a higher retreatment need. However, for the lateral profile appearance rating, the highest mean belonged to the

necessary retreatment needs group, followed by unnecessary and dispensable retreatment needs groups.

3.4 Retreatment needs affected by specific self-perceived dental alignment and occlusal status

Fourteen specific questions regarding self-perceived dental alignment and occlusal status were further analyzed for their relationship with retreatment needs (Fig. 1). In addition to tooth clenching, all remaining 13 conditions that indicated poor dental alignment and occlusal status showed consistency with a high retreatment need. Moreover, the rest showed a significant correlation with the retreatment needs except for clenching and tooth missing.

3.5 Retreatment needs affected by specific self-perceived oral function and psychology

Fig. 2 shows the retreatment needs based on oral function and psychology. The results showed a significant correlation between retreatment needs and teeth alignment affected pronunciation, dental cleanliness, confidence, smile and loud speech. In contrast, when poor occlusion affected normal eating and chewing, the need for retreatment of the respondents was relatively lower but significant.

3.6 Appearance and psychological status affected by self-perceived dental alignment and occlusal status

The relationship between self-perceived dental alignment and occlusal status and self-evaluation of appearance and psychology were further analyzed (Fig. 3). The rating of front facial appearance was influenced by tooth crowding or gapping, tooth missing, tooth shifting, tooth clenching, bad occlusion, crossbite and uneven midline. Self-perceived tooth alignment was related to tooth crowding or gapping, tooth shifting and anterior tooth area condition, including malocclusion of front

TABLE 2. Response to fourteen questions regarding self-perceived dental alignment and occlusal status.

Questions and Answers	n (%)
3a How is the alignment of your teeth?	
Well	511 (31.8%)
Not sure	125 (7.8%)
Crowded or gapped	973 (60.5%)
3b Do you have missing teeth?	
No	1054 (65.5%)
Not sure	98 (6.1%)
Yes	457 (28.4%)
3c Are your teeth gradually shifting?	
No	561 (34.9%)
Not sure	288 (17.9%)
Yes	760 (47.2%)
3d Do you have loose teeth?	
No	991 (61.6%)
Not sure	137 (8.5%)
Yes	481 (29.9%)
3e Do your upper and lower teeth make contact when you clench hard?	
Yes	1025 (63.7%)
Not sure	187 (11.6%)
No	397 (24.7%)
3f Do your upper and lower teeth make contact while relaxing?	
No	582 (36.2%)
Not sure	191 (11.9%)
Yes	836 (52.0%)
3g Do your upper and lower lips make contact while relaxing?	
No	988 (61.4%)
Not sure	124 (7.7%)
Yes	497 (30.9%)
3h Do you feel like having bad occlusion of teeth?	
No	814 (50.6%)
Not sure	243 (15.1%)
Yes	552 (34.3%)
3i Which of the conditions do you think you have in your front teeth?	
Normal	705 (43.8%)
Not sure	111 (6.9%)
Inclination or protrusion	793 (49.3%)
3j Which of the conditions do you think exist on your lips?	
Normal	755 (46.9%)
Not sure	125 (7.8%)
Inclination or protrusion	729 (45.3%)

TABLE 2. Continued.

Questions and Answers	n (%)
3k Which of the conditions do you think of your chin?	
Normal	703 (43.7%)
Not sure	119 (7.4%)
Inclination or protrusion	787 (48.9%)
When the posterior teeth are clenched, ...	
3l which of the conditions do you think of your anterior teeth from the upper and lower directions?	
-The upper anterior teeth cover about 1/3 of the lower anterior teeth	417 (25.9%)
-Not sure	100 (6.2%)
-The upper anterior teeth cover about 2/3 of the lower anterior teeth or the upper anterior teeth almost flush with the lower anterior teeth	582 (36.2%)
-The upper anterior teeth completely cover the lower anterior teeth or the upper anterior teeth do not cover the lower anterior teeth	510 (31.7%)
3m what are the conditions on your upper and lower front teeth in the anterior and posterior directions?	
-The upper anterior teeth in front of the lower anterior teeth	493 (30.6%)
-Not sure	135 (8.4%)
-Upper anterior teeth aligned with or behind the lower anterior teeth	981 (61.0%)
3n are your upper and lower teeth aligned centrally?	
-Yes	683 (42.4%)
-Not sure	208 (12.9%)
-No	718 (44.6%)

TABLE 3. Response to six questions regarding oral function and psychological evaluation.

Questions and Answers							n (%)
Do you feel that your bite is interfering with eating and chewing?							
No							557 (34.6%)
Not sure							185 (11.5%)
Yes							867 (53.9%)
Do you feel that your teeth interfering with normal pronunciation?							
No							678 (42.1%)
Not sure							213 (13.2%)
Yes							718 (44.6%)
Mean	SD ¹	P ₂₅	P ₅₀	P ₇₅	Range	Notes	
How is your teeth affect your...							
tooth brushing?	3.32	1.29	2.00	3.00	4.00	1–5	The lower the rating, the higher the self-evaluation
confidence?	3.00	1.27	2.00	3.00	4.00	1–5	
loud speak?	2.98	1.45	2.00	3.00	4.00	1–5	
smile?	3.00	1.31	2.00	3.00	4.00	1–5	

SD: standard deviation.

TABLE 4. Correlation analysis of scores, gender and orthodontic retreatment need.

Scores of...	Scores of...					gender	retreatment need
	front appearance	lateral profile appearance	tooth alignment	self-perceived dental alignment and occlusal status	oral function and psychology		
Scores of...							
front appearance	1						
lateral profile appearance	0.113**	1					
tooth alignment	0.175**	0.151**	1				
self-perceived dental alignment and occlusal status	-0.020	0.088**	-0.031	1			
oral function and psychology	-0.138**	0.058*	-0.111**	0.281**	1		
gender	-0.026	0.018	-0.006	0.042	0.032	1	
retreatment need	0.079**	-0.074**	0.067**	-0.251**	-0.278**	-0.046	1

*Indicates significant correlation ($p < 0.05$) at the 0.05 level (two-tailed); **Indicates significant correlation ($p < 0.01$) at the 0.05 level (two-tailed).

TABLE 5. Scores of different assessment aspects and orthodontic retreatment need.

Scores of...	Need of orthodontic retreatment (Mean \pm SD ¹)			
	Necessary	Dispensable	Unnecessary	p value ²
front appearance	6.32 \pm 1.35	6.62 \pm 2.27	6.79 \pm 1.98	0.01
lateral profile appearance	6.85 \pm 2.26	6.46 \pm 2.27	6.57 \pm 2.24	0.01
tooth alignment	6.32 \pm 2.23	6.42 \pm 2.29	6.78 \pm 2.18	0.01
self-perceived dental alignment and occlusal status	13.78 \pm 3.80	12.39 \pm 4.62	10.13 \pm 5.03	0.00
oral function and psychology	15.49 \pm 3.27	13.70 \pm 4.03	12.10 \pm 4.82	0.00

¹SD indicates standard deviation; ² p value of Kruskal-Wallis test.

teeth, lips and chin. For psychological conditions regarding tooth cleaning, confidence, loud speaking and smiling, almost all dimensions of self-perceived dental alignment and occlusal status were related, except tooth missing, tooth clenching and deep bite.

4. Discussion

4.1 Multifaceted causes for orthodontic retreatment

Given the steady development in orthodontics within the past decades, a great proportion of patients with a history of orthodontic treatment, especially during childhood and adolescence, were found to undergo orthodontic retreatment [4, 10]. However, the uneven development and distribution of orthodontic medical resources have generated conflicts between the patient's perception of orthodontic treatment outcomes and local orthodontic medical resources, leading to dissatisfied results about their undergone orthodontic treatment [1, 2].

Original treatment failure might be attributed to biological development, especially for those who received treatment during childhood and adolescence, patient factors, and original orthodontists'-related issues [4]. From 3 to 18 years of age, the sagittal and vertical growth of the maxilla and mandible undergoes a rapid remodeling process [9]. The eruption and development of the maxillary and mandibular teeth also affect dental development [9]. As a result, these might trigger unfavorable skeletal growth, temporomandibular joint (TMJ) degeneration and ankylosed teeth, causing secondary malocclusion [4]. Faults such as poor treatment, inadequate retention and failure of adequate camouflage could be caused by the lack of experience or resources of the initially treated orthodontists [4]. Patient factors could involve poor retention compliance and unmet expectations. Thus, all these, together or individually, could contribute to the rising need for orthodontic retreatment in this age group [11–13].

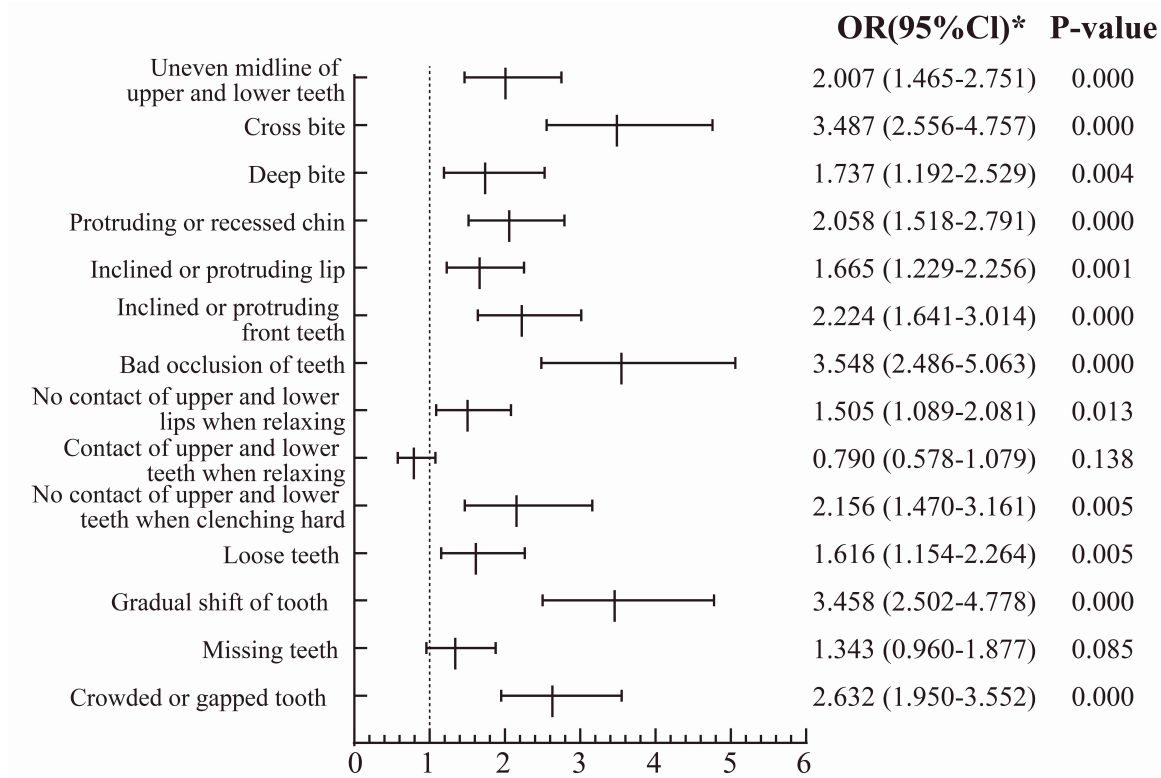


FIGURE 1. Need of orthodontic retreatment regarding self-perceived dental alignment and occlusal status. Results of self-perceived dental alignment and occlusal status influencing retreatment need is shown in Fig. 1. In addition to “contact of upper and lower teeth when relaxing”, the remaining 13 conditions that indicated poor dental alignment and occlusal status. *OR: odds ratio, which represents the odds that an outcome will occur given a particular exposure, compared to the odds of the outcome occurring in the absence of that exposure. CI: confidence interval estimate, 95% CI means that there is a 95% probability that the confidence interval will contain the true population mean.

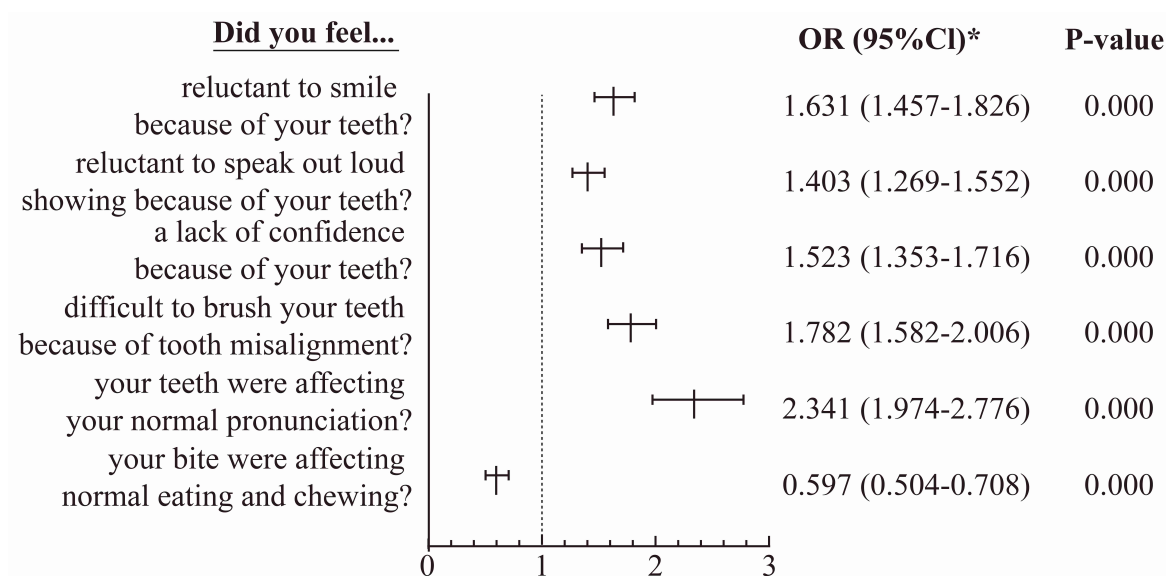


FIGURE 2. Need of orthodontic retreatment regarding oral function and psychological evaluation. Significant correlations between need of orthodontic retreatment and pronunciation, dental cleanliness and psychological status such as confidence, smile, and loud speech are conducted, while when the poor occlusion affected normal eating and chewing, the retreatment need of the respondents was lower and equally significant. *OR: odds ratio, which represents the odds that an outcome will occur given a particular exposure, compared to the odds of the outcome occurring in the absence of that exposure. CI: confidence interval estimate, 95% CI means that there is a 95% probability that the confidence interval will contain the true population mean.

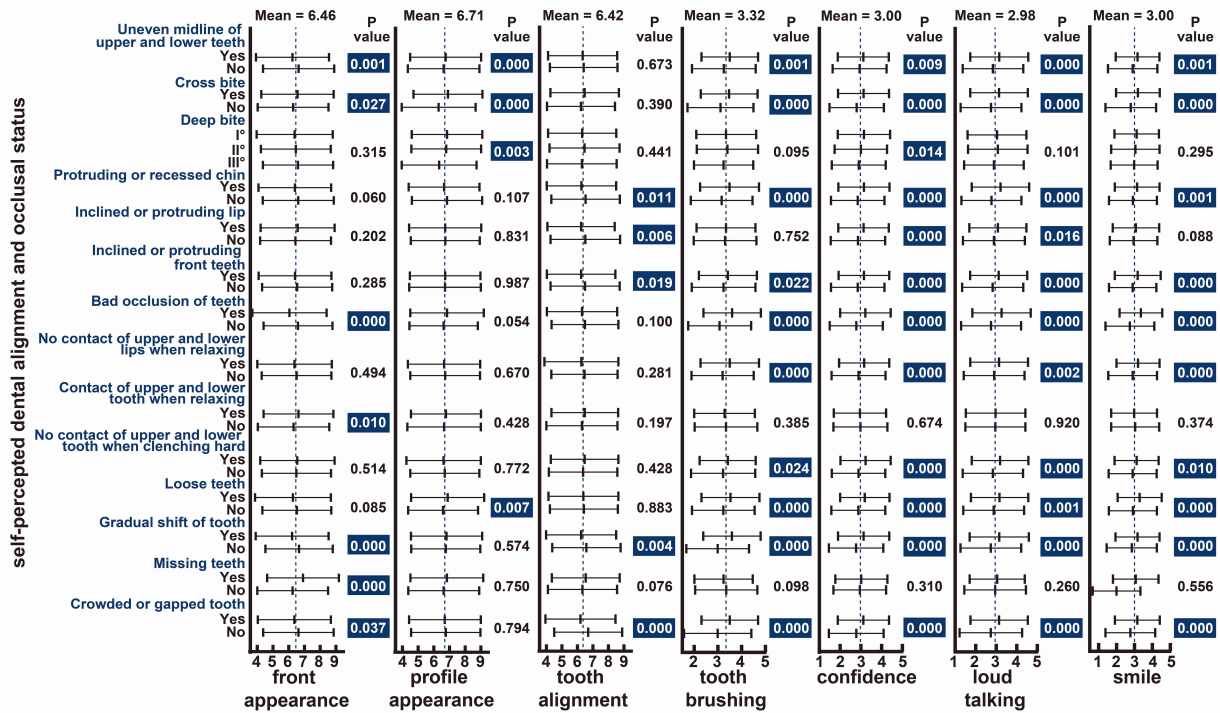


FIGURE 3. Rating of appearance, oral function and related psychology status regarding self-perceived dental alignment and occlusal status. Front appearance rating is mainly influenced by tooth crowding or gapping, tooth missing, tooth shifting, tooth clenching, bad occlusion, cross bite and uneven midline. The rating of the lateral profile appearance is in correlation with tooth loosening, deep bite, cross bite and uneven midline. And self-perceived tooth alignment is related to tooth crowding or gapping, tooth shifting and anterior tooth area condition, including malocclusion of front teeth, lips and chin. Psychology condition are mainly affected by all aspects of self-perceived dental alignment and occlusal status, except tooth missing, tooth clenching and deep bite.

4.2 Pursuit of front facial appearance promoted retreatment need, with more emphasis on facial harmony of the lower part

A statistical analysis by Luke Chow *et al.* [4] showed that patients seeking retreatment were mostly self-motivated rather than influenced by others, with most mainly due to aesthetic concerns. In our present study, both front appearance and lateral profile appearance were associated with orthodontic retreatment needs. We found that a stronger discontent in front appearance was associated with a stronger desire for orthodontic retreatment. Nevertheless, the opposite result occurred in the analysis of the lateral profile appearance, as a higher self-perception led to an increasing need for retreatment. Such findings reflect that the lateral profile appearance may have already been improved after the first orthodontic treatment; hence, patients who needed orthodontic retreatment usually already had a good base of lateral profile appearance.

However, despite the well-established general lateral profile appearance, further in-depth analyses indicated that patients with retreatment needs had a higher pursuit of beauty and were more focused on the lower part of their face, such as the self-perceived abnormal position of lips and chin, which resulted in dissatisfaction with their lateral profile appearance. These findings were consistent with previous studies which showed that the relationship between lips and nose-chin line (E-line) contributed much to lateral profile appearance [14, 15]. Except

for inclining or protruding chin, chin asymmetries were also noted to be related to attractiveness, suggesting that future studies on orthodontic retreatment needs could focus more on the soft tissue of the lower face, as they also contribute to the overall facial aesthetics [16].

Together, these findings provide additional knowledge on the basis of previous studies regarding inconsistent results on the improvement of self-perceived appearance and orthodontic treatment history, which proposed worsened self-perceptions and no differences for orthodontic-treated patients compared with untreated ones [17]. Patients undergoing orthodontic treatment often have high expectations for changes in their appearance, whereby mild treatment procedures lead to under-expected self-perceived outcomes. Hence, regardless of well-established general lateral profile appearance, patients with retreatment needs choose orthodontic retreatment in pursuit of better front appearance and higher facial harmony of the lower part.

4.3 Pursuit for better pronunciation and psychological status contributed to retreatment need

Orthodontic treatment might not only often result in appearance changes but also non-negligible effects on oral function and psychological status [18, 19]. For driving factors such as abnormal oral functions, the present survey showed that a greater abnormality in normal pronunciation was associ-

ated with a greater need for orthodontic retreatment, which demonstrated the greatest OR value. However, the analysis of other measures of oral function in the present study, such as eating and chewing, showed that greater satisfaction in this function was associated with a stronger desire for orthodontic retreatment, which was opposite from the results of surveys focusing on the need for initial orthodontic treatment [18]. These findings suggested that patients with retreatment needs and acceptable eating and chewing functions after their initial treatment desired decent oral function, such as pronunciation, which is worth noting for orthodontists.

Regarding oral-related psychological factors, we surveyed dental cleanliness, self-confidence, loud speech and smile. The results showed that failure to achieve all four were driving factors for patients to choose orthodontic retreatment, indicating that initial orthodontic treatment might not have necessarily positively affected the patients' psychological status. These are in agreement with Shaw *et al.* [20], who claimed that orthodontic treatment had no discernable positive effect on psychological outcomes in a 20-year cohort study. Also, in a 20-year follow-up study by Kenealy *et al.* [21], the authors reported that there was little evidence to show that orthodontic treatment history had a significant promotion on psychological health variables. Thus, these suggest that the promotive effects of orthodontic treatment on psychological status might not be as satisfactory as expected, making it one of the clinical problems to be solved.

4.4 Complex intraoral factors influenced retreatment needs in various aspects

Except for tooth clenching and missing, relatively low self-evaluation of patients calling for retreatment was associated with almost all 14 indicators of intraoral factors, among which the anterior region of the tooth was most focused. These findings concord with the analysis of do Amaral *et al.* [22], who reported that in eight types of malocclusions involving crowding teeth, maxillary overjet and molar relation were significantly correlated to self-perceived needs for first orthodontic treatment.

Additionally, previous studies revealed that general dental occlusion status weighted most for each time of orthodontic treatment, whereby severe malocclusions caused both appearance dissatisfaction and oral dysfunction as they affected smiling, chewing and tooth cleaning [23–25]. The anterior region of the tooth contributes to lateral profile appearance. Previous literature showed that unfavorable changes in the position of the incisor could lead to poor esthetics of soft tissues of the lips, nose and chin [26, 27]. Patients suffering from open bite malocclusion were observed to have reduced palatal diameters and long-term impairment involving altered loading of TMJ and masticatory functions [28].

Moreover, our in-depth analysis showed that intraoral factors might contribute as the base for all chief complaints during orthodontic retreatment. Misaligned teeth, tooth shifting, uneven midline, and crossbite generally impacted the patient's cosmetic self-evaluation. For intraoral factors-related oral function and psychological status, we found that almost all 14 factors of self-perceived dental alignment and occlusal

status were significantly related to psychological levels. Of note, tooth missing, which was probably related to the initial orthodontic extraction treatment, improved the patients' self-evaluation of their appearance after the initial treatment, although this effect was significant only in the front facial appearance. Additionally, the confidence, loud speech and smile of tooth-missing patients were promoted to a certain extent.

Hence, we proposed that related intraoral factors were relatively complex for patients with retreatment needs and were associated with self-perceived appearance, oral function and psychological status, indicating intraoral factors as the base. In addition, intraoral factors had a much more significant impact on the patient's psychological status than appearance, suggesting that orthodontists should pay more attention to the psychological state of their patients, especially those requiring retreatment. Initial orthodontic extraction treatment seems to deliver better outcomes as a higher self-perceived appearance and psychological status of the patients were observed.

4.5 Limitations

There were some limitations worth mentioning in this study. The participants were mainly from the western region of China; hence, our results cannot be generalized to objectively reflect the overall orthodontic retreatment situation in contemporary China. Background investigations for patients with orthodontic treatment history were relatively deficient; for instance, we did not investigate the type of appliance used and retention duration, which are highly related to relapse and orthodontic retreatment. Thus, future studies are needed to validate our findings and could conduct a more in-depth analysis of the relationship between specific intraoral factors, such as appearance and oral function, as intraoral factors seem to be the basic influence factor of retreatment needs.

5. Conclusions

Given the increasing number of patients seeking orthodontic retreatment in contemporary China despite having undergone an initial orthodontic treatment in their adolescence, a lack of literature on such topics necessitated a more comprehensive understanding of their needs to provide a critical guide to clinical practice. Our study contributed to understanding the underlying motivations of these patients, which are summarized as follows:

1. College freshmen in contemporary China are in high need of orthodontic retreatment, although they have undergone orthodontic treatment during childhood and adolescence.
2. Patients requiring retreatment often aim to obtain a better front facial appearance with a well-established lateral profile appearance, decent aesthetic features of the anterior region of the tooth, and facial harmony of the lower part, representing an essential expression of higher self-demands of general appearance.
3. The unsatisfied psychological status in all aspects can be considered the most important driver for needing orthodontic retreatment, while the enhancement of oral functions such as pronunciation cannot be ignored.

4. Various intraoral factors could be considered as a base to solve the underlying demand of retreatment patients, including general tooth alignment and features of the anterior teeth region.

Altogether, our study further supplements and complements our current understanding on the need for orthodontic retreatment, especially in college freshmen. As a growing number of patients are seeking orthodontic retreatment, further studies concentrating on the intrinsic drivers of these patients are needed to shed more light on this topic.

AVAILABILITY OF DATA AND MATERIALS

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

AUTHOR CONTRIBUTIONS

TYW and YWG—designed the research study; wrote the manuscript. TYW, HLL and WBX—performed the research. FH—provided help and advice. TYW—analyzed the data. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was approved by the ethics committee of West China Hospital of Stomatology, Sichuan University. Project Approval Number: WCHSIRB-D-2021-441. All methods were carried out in accordance with relevant guidelines and regulations. Informed consent was obtained from all subjects and/or their legal guardian(s).

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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