Research Square

Preprints are preliminary reports that have not undergone peer review. They should not be considered conclusive, used to inform clinical practice, or referenced by the media as validated information.

Investigation on the prevalence of malocclusion and analysis of oral health-related quality of life in children aged 6-12 years in Jinzhou

Jianhui Xu
The Second Affiliated Hospital of Jinzhou Medical University
Xin Li (**httplixin@163.com**)
The Second Affiliated Hospital of Jinzhou Medical University
Xiaoyu Liu
The Second Affiliated Hospital of Jinzhou Medical University
Siwei Li
The Second Affiliated Hospital of Jinzhou Medical University
Xueqin Wang
The Second Affiliated Hospital of Jinzhou Medical University
Jin Liu
The Second Affiliated Hospital of Jinzhou Medical University

Research Article

Keywords: malocclusion, children, epidemiological investigation, risk factors, oral health-related quality of life

Posted Date: April 21st, 2022

DOI: https://doi.org/10.21203/rs.3.rs-1544897/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Abstract

Background

Malocclusion can present a variety of clinical forms and manifestations, which affect children's oral health and lead to psychological problems.However, among children in Jinzhou, there are few reports on the prevalence of malocclusion and the effect of malocclusion on oral health-related quality of life.

Methods

A total of 2162 children aged 6−12 years were randomly selected from various districts of Jinzhou. Conventional clinical examination was performed by stomatologists, and the results were described based on the Angle malocclusion classification. Further, questionnaires survey completed by children’s parents or guardians provided the demographic data, life style, and oral habits.

Results

The incidence of malocclusion in children aged 6 to 12 in Jinzhou was 67.90%, including 1129 males and 1033 females, accounting for 52.22% and 47.78% of males and females, respectively.According to Angle's classification, the incidence of Angle , Angle and Angle malocclusion was 46.48%, 8.14% and 12.03%, respectively.If classified according to clinical symptoms, the most common type is dentition crowding, with an incidence of 71.79%.Common risk factors include heredity, bad oral habits and so on. In addition, malocclusion has a negative effect on oral health-related quality of life of children aged 6–12 years in Jinzhou.

Conclusions

The prevalence rate of malocclusion in 6-12-year-old children in Jinzhou is high, children and parents have weak awareness of oral health care. In addition,heredity and bad oral habits are common risk factors for malocclusion. Malocclusion has a negative effect on children's oral health-related quality of life.

Background

Malocclusion refers to the teeth, jaw, and craniofacial deformities and is mainly manifested as individual tooth dislocation, abnormal arch shape and tooth arrangement, and abnormal relationship of the dental arches, jaw, and craniofacial structure. The World Health Organization (WHO) defines malocclusion as "handicapping dentofacial anomaly", malocclusion disorders are caused by the congenital (genetic) and acquired (environmental) factors. General statistical results have shown that 60−70% of malocclusion

cases are related to acquired factors mainly including the bad oral habits, abnormal oral function, and children's dental replacement disorder [1].

Malocclusion is mainly characterized by the morphological abnormalities; however, it may also affect the function, development, health, and beauty of the stomatognathic system. Since malocclusion is formed during the growth and development of maxillofacial region, developmental deformities of jaw and face are possible. For instance, the anterior crossbite, where the upper and lower anterior teeth are in a reverse occlusal relationship, and the lower dental arch hinders the forward development of the upper dental arch, resulting in insufficient maxillary development.

Malocclusion can also affect the health of dislocated teeth; due to the irregular arrangement of teeth, the teeth are not easy to self-clean, and food residues are easy to remain, leading to periodontitis and caries. At the same time, periodontal damage caused by occlusal interference or early contact due to tooth dislocation can result in abnormal periodontal ligament and alveolar bone absorption. The disorder of occlusal relationship caused by malocclusion affects the normal masticatory function and masticatory pressure. As a result, food cannot be fully chewed and may lead to gastrointestinal dysfunction. Malocclusion can not only cause abnormal position of teeth and jaws, but also cause movement disturbance of mandibular opening and closing; for instance, severe anterior occlusive occlusion, obvious occlusal interference, and occlusal trauma. Malocclusion can affect the appearance of the face, such as irregular arrangement of teeth, abnormal arrangement of dental arch and jaw, affecting the appearance of the face, and sometimes cause mental and psychological abnormalities[2]. Malocclusion is harmful to the oral occlusal system in many ways, and sometimes has a very serious impact on development and function. Therefore, the goal of oral correction of malocclusion is to restore the balance, function, and appearance of the whole occlusal system. The standard of orthodontic treatment is individual normal occlusion, not ideal normal occlusion. That is, any slight malocclusion that does not interfere with the physiological function can be included in the category of normal occlusion. This kind of individual occlusion within the normal category is different from each other, so it is called individual normal occlusion. The ideal normal occlusion was put forward by Angle, that is, the whole pair of teeth are preserved, the teeth are arranged neatly on the upper and lower dental arches, the apical fossa relationship between the upper and lower teeth is completely correct, and the occlusal relationship between the upper and lower dental arches is very ideal, which is called ideal normal occlusion. After the treatment of malocclusion, the craniofacial morphology, function, and profile of teeth and jaws have achieved a new balance and coordination. The results of the national survey published by Fu Minkui in 2000 show that the malocclusion of Chinese children is as high as 71.21% in the mixed dentition stage and 72.92% in the initial stage of permanent teeth [3].

The incidence of malocclusion increased significantly from deciduous tooth stage to mixed tooth stage. Bad oral habits are one of the main causes of malocclusion[4]. However, the malocclusion of permanent dentition is closely related to the existence and development of early deciduous dentition and mixed dentition malocclusion. Malocclusion can affect the development of occlusal maxillofacial, oral health

function, and appearance. It can also cause harm to the whole body, and even cause serious psychological and mental disorders[5].

There are relatively few epidemiological investigations on malocclusion in children at home and abroad, especially in Liaoning Province.The epidemiological investigations of malocclusion in children in China are mostly limited to the objective statistical analysis of the existing situation, while little research on the related risk factors of malocclusion. In the course of this study, the causes of malocclusion in children were analyzed by questionnaire, leading to the targeted oral health education about this disease. Mastering the oral health level of 6-12-year-old children in Jinzhou not only fills the gap in the city's data in this field but also provides critical support to evaluate oral health development in the future.

Methods

Survey objects

In this study, a total of 2,162 children aged 6–12 years were selected from all the districts in Jinzhou city of China. The inclusion criteria were as follows: (1) children aged 6–12 in Jinzhou City, (2) consent and active cooperation to the questionnaire survey and clinical examination, (3) informed consent to the survey, and (4) healthy and free of mental and any other diseases. Further, the exclusion criteria were: (1) children whose parents did not sign or refused the informed consent form, (2) children who were not in school on the day of examination, (3) children who are still unable to cooperate with the examination after psychological induction, (4) children who were receiving or had received orthodontic treatment, (5) children with local or systemic problems, or trauma affecting the facial development, (6) children with cleft lip and palate, and (7) children without eruption of the first permanent molars.

Inspection method

Clinical examination was performed under natural light; the stomatologists used the conventional oral examination instruments (plane stomatoscope, dental curved forceps, and No. 5 probe) to record the examination results according to the Angle Malocclusion classification and individual normal occlusion. The questionnaire survey included descriptions on the oral hygiene, bad habits, and behavior related to indentify the risk factors of malocclusion. In addition, the Chinese version of OHIP-14 questionnaire [6] was used to explore the effect of malocclusion on the oral health-related quality of life. The survey was distributed by the school teacher to the parents, collected by the health care doctor, and examined and filled by the investigator.

Judgment criteria

Normal dentition was considered as the standard, while the malocclusion was defined based on the Angle malocclusion classification method. Further, the malocclusion shape was also classified and counted according to the Angle (class I, II and III) classification method. Normal occlusion was based on the mesial-distal relationship between the maxilla and mandible and the normal dental arch, with neutral

molar relationship. Normal occlusion can be further described as the median occlusion position where the mesial buccal tip of the maxillary first permanent molar engages in the mesial buccal groove of the mandibular first permanent molar, but there was a slight malocclusion deformity in the dental arch, which did not greatly hinder the physiological process. Since this kind of individual occlusion within the normal category was different from each other, it was called as the individual normal occlusion. Class I deformity (neutral malocclusion) was characterized by the crowding of anterior teeth, protrusion of upper arch, protrusion of double arches, reverse occlusion of anterior teeth, and buccal lingual dislocation of posterior teeth. Class II deformity included distal malocclusion (labial and lingual inclination of maxillary incidors). Class III malformation included the mesial malocclusion on one side and neutral malocclusion on the other side.

Examiner calibration

In order to avoid the bias of the inspector, two inspectors repeated the inspection during the examination. Reliability test in the early stage of epidemiological investigation, all six inspectors received clinical training on malocclusion. Before the final investigation, the reliability of the inspector was evaluated by reliability test on 20 subjects (including 1 reference examiner and 3 candidates). Kappa coefficients within inspectors were 0.90, 0.92, and 0.87 respectively, while the kappa values between inspectors were 0.80. During the survey, 5% of the subjects were selected for the second reliability test, and their kappa coefficient values were greater than 0.85.

Statistical analysis

EpiData was used for double entry of the survey data, and SPSS 25.0 was used for statistical processing of all the data. In addition, all the data were tested for normality before analysis. The percentage was used to describe the distribution of occlusion and malocclusion, and the Pearson chi square test was used for two factor analysis. The statistically significant variables were further included in the binary logistic regression analysis, and the odds ratio (OR) and 95% confidence interval (CI) were calculated to distinguish the risk factors, test level $\alpha = 0.05$, $p < 0.05$ was considered statistically significant.

Result

Differences of malocclusion in sex, age, ethnic groups, urban and rural areas. Among those 2200 participants, 15 students did not complete the questionnaire survey, 7 students' parents did not sign the informed consent forms, and 16 students were excluded for missing the inclusion criteria. Finally, 2162 participants received a complete clinical examination and a questionnaire survey, with a participation rate of 98.27%. Among those students, 1129 were male, accounting for 52.22%, of which 768 cases suffered from malocclusion with a prevalence rate of 68.02%; 1033 were females, accounting for 47.78% of the total, including 700 children with malocclusion, with a prevalence rate of 67.76%. There was no significant difference between the sexes ($p > 0.05$). There were significant differences in the prevalence rate of malocclusion among the seven age groups from 6 to 12 years old ($p < 0.05$), with the rising prevalence rate of malocclusion in children aged 6 to 8 years: 69.90%(6), 75.08%(7), and 73.79%(8),

respectively. Malocclusion was seen in 65.10 percent of children aged 9 years old, 64.65 percent of children aged 10 years old, 64.30 percent of children aged 11 years old, and 65.69 percent of children aged 12 years(Fig. 1).

The survey found no significant difference in the prevalence of malocclusion among children of different ethnic groups in Jinzhou ($p > 0.05$).In addition, there was no significant difference in the prevalence of malocclusion between children living in rural and urban areas ($p > 0.05$). And there is no difference in the prevalence of malocclusion among children from different economic backgrounds(Table 1).

Table 1
Comparison of the prevalence of malocclusion among sex, age, nationality and household registration types

		Total (N = 2162)	**Maocclusion (n = 1468)**	**Normal(n = 694)**	χ^2	*p*
		N(%)	n(%)	n(%)		
Gender						
	Male	1129(52.22)	768(68.02)	361(31.98)	0.017	0.897
	Female	1033(47.78)	700(67.76)	333(32.24)		
Age						
	6	102(4.72)	71(4.84)	31(4.47)	18.726	0.005
	7	289(13.37)	217(14.78)	72(10.37)		
	8	351(16.23)	259(17.64)	92(13.26)		
	9	447(20.68)	291(19.82)	156(22.48)		
	10	430(19.89)	278(18.94)	152(21.90)		
	11	339(15.6%)	218(14.85)	121(17.44)		
	12	204(9.44)	134(9.13)	70(10.08)		
Nationality						
	Han	1752(81.04)	1182(80.52)	570(82.13)	1.057	0.590
	Man	355(16.42)	246(16.76)	109(15.71)		
	Other	55(2.54)	40(2.72)	15(2.16)		
Area						
	City	1925(89.04)	1308(89.10)	617(88.90)	0.019	0.892
	Countryside	237(10.96)	160(10.90)	77(11.10)		

Prevalence of malocclusion according to Angle's classification

The results showed that among the 2162 subjects, there were 1005 Angle Class I malocclusion cases, accounting for the highest proportion of malocclusion (46.48%), followed by individual normal occlusion in 694 cases (32.10%), and Angle Class III in 260 cases (12.03%), since the lowest prevalence rate was Angle Class II (9.39%). The distribution of Angle classification in each dental age was basically the same, and Angle class I was the most common. The distribution of Angle classification is shown in Table 2.

Table 2
The constituent ratio of Angle class I ~ III in different genders

Angle classification	Male(n = 1129)		Female(n = 1033)		Total(N = 2162)	
	n	(%)	n	(%)	N	(%)
	514	45.53	491	47.53	1005	47.27
1	76	6.73	54	5.23	130	6.01
2	39	3.45	34	3.29	73	3.38
	139	12.31	121	11.71	260	12.03

Distribution of common clinical manifestations of malocclusion

Table 3 shows the prevalence of different typical clinical manifestations of malocclusion, with dentition crowding being the most prevalent (71.79%), followed by a deep overbite, crossbite, dentition scattered in the space, deep overjet, end-to-end occlusion, and anterior open bite. The prevalence rates were 39.32%, 16.10%, 12.07%, 8.93%, 4.02%, and 2.08%, respectively (Table 3). Except for 694 (32.10%) individual normal occlusions, 8.14% of the children had only one malocclusion. Most children (47.46%) showed two or four kinds of malocclusion at the same time, while 12.30% had five or more malocclusion types. The severity of malocclusion in the subjects is shown in Fig. 2.

Table 3
Distribution of common clinical manifestations of malocclusion

Clinical symptoms		Total N (%)		Male n (%)		Female n (%)		χ^2	*p*
Dentition crowding									
	Normal	610	28.21	297	26.31	313	30.30	4.248	0.039
	Crowd	1552	71.79	832	73.70	720	69.70		
Deep overbite									
	Normal	1312	60.68	661	58.55	651	63.02	4.524	0.033
	Deep overbite	850	39.32	468	41.45	382	36.98		
Deep overjet									
	Normal	1752	81.04	899	79.63	853	82.58	3.049	0.081
	Deep overjet	410	18.96	230	20.37	180	17.42		
Dentition space									
	Normal	1901	87.93	991	45.84	910	88.09	0.051	0.822
	Dentition space	261	12.07	138	6.38	123	11.91		
Crossbite									
	Normal	1814	83.90	942	83.44	872	84.41	0.382	0.537
	Crossbite	348	16.10	187	16.56	161	15.59		
Anterior open bite									
	Normal	2117	97.92	1104	97.79	1013	98.06	0.205	0.651
	Anterior open bite	45	2.08	25	2.21	20	1.94		
Anterior edge-to-edge occlusion									
	Normal	2075	95.98	1085	96.10	990	95.84	0.098	0.754
	Anterior edge-to-edge occlusion	87	4.02	44	3.90	43	4.16		

The composition of different degrees of deep overbite, deep overjet and anterior open bite are shown in Fig. 3, among which, I ° deep overbite, I °deep overjet and I °anterior open bite accounted for the largest proportion in their respective classification, with a constituent ratio of 40.35%, 51.95% and 48.89%, respectively.

Analysis of risk factors related to malocclusion

The terrible oral habits of Jinzhou children aged 6 to 12 were evaluated using a questionnaire as part of this study. Binary linear regression analysis was utilized to examine the risk factors associated with malocclusion after the data was entered into the computer. The results showed that while BMI index had no significant difference in the occurrence of malocclusion ($p > 0.05$), sexes, caries, bad oral habits, retention of deciduous teeth, and low labial frenum did ($p < 0.05$) (Fig. 4).

In the course of this study, we investigated the frequency and duration of oral bad habits among 6 ~ 12 years old children in Jinzhou by way of questionnaire. It was found that the higher the frequency and duration of oral bad habits, the greater the possibility of malocclusion (Table 4), and the difference was statistically significant ($p < 0.05$).

Table 4
The relationship between the duration and frequency of bad oral habits and malocclusion

		Maocclusion(n)	Individual normal occlusion(n)	Total (N)	Ratio(%)	χ^2	*p*
Duration							
	Never	1165	586	1751	66.53	10.172	0.006
	More than one month	69	26	95	72.63		
	More than one year	234	82	316	74.05		
Frequency							
	Never	1143	569	1712	66.76	8.553	0.036
	Lasting a few minutes a day	228	99	327	69.72		
	Lasting tens of minutes a day	46	14	60	76.67		
	Lasting several hours a day	51	12	63	80.95		

Effect of malocclusion on oral health-related quality of life

The Chinese version of OHIP-14 scale was used to evaluate the quality of life related to oral health[3].Firstly, the relationship between sex, age, ethnic groups, socio-economic status and the total score which had been investigated (Table 5) showed that no significant difference in the scores of oral health-related quality of life in sex, age, ethnic groups, and socio-economic conditions($p > 0.05$).The effect of socio-economic factors on oral health quality of life is greater than that of malocclusion. Some pertinent studies have reported a significant correlation between low family income and the negative impact of early dental caries on oral health quality of life in children. However, no significant correlation was found between malocclusion and oral health quality of life[7].

Table 5
Relationship between gender, age, nationality, socio-economic status and OHIP-14 scores of children in Jinzhou

		n(%)	OHIP-14 (Mean ± SD)	Statistics	
Gender				t	*p*
	Male	1129(52.22)	6.44 ± 8.445	0.104	0.917
	Female	1033(47.78)	6.48 ± 8.160		
Age				H	*p*
	6	102(4.72)	8.59 ± 8.605	10.788	0.095
	7	289(13.37)	7.13 ± 9.876		
	8	351(16.23)	5.98 ± 8.209		
	9	447(20.68)	6.24 ± 8.189		
	10	430(19.89)	6.55 ± 7.990		
	11	339(15.68)	6.06 ± 7.710		
	12	204(9.44)	6.22 ± 7.497		
Nationality				F	*p*
	Han	1752(81.04)	6.52 ± 8.441	0.412	0.662
	Man	355(16.42)	6.11 ± 7.744		
	Other	55(2.54)	6.80 ± 7.022		
Socio-economic status(yuan)*				H	*p*
	<32189	713(32.98)	6.24 ± 8.140	0.756	0.685
	32189–64378	1243(57.49)	6.52 ± 8.039		
	>64378	206(9.53)	6.86 ± 10.171		

*: According to the per capita income level of Chinese residents in 2020

The average score of each item in OHIP-14 and the percentage of individuals who have experienced negative effects (choosing the option of "very often" or "often" to think that the item has a negative impact on individuals) are shown in Table 6. "Physical pain" is the most common negative impact, accounting for 3.65%, followed by "psychological discomfort", which is also a common occurrence accounting for 3.56%.The item with the least impact on individuals is "social disorder", accounting for only 1.61%.

Table 6
Score of each item in OHIP-14 scale and percentage of individuals with negative impact

	Malocclusion		Individual normal occlusion		t	*p*
	Mean ± SD	(%)*	Mean ± SD	(%)*		
Functional limitation	0.88 ± 1.425	3.05	0.92 ± 1.442	1.71	-0.522	0.601
Physical pain	1.66 ± 1.684	3.65	1.63 ± 1.667	1.62	0.456	0.649
Psychological discomfort	0.99 ± 1.551	3.56	1.05 ± 1.584	1.48	-0.746	0.456
Physical disability	1.00 ± 1.459	2.22	0.98 ± 1.413	0.83	0.303	0.762
Psychological disability	0.85 ± 1.330	1.85	0.88 ± 1.354	0.97	-0.546	0.585
Social disability	0.52 ± 1.128	1.16	0.54 ± 1.160	0.51	-0.471	0.638
Handicap	0.52 ± 1.190	1.71	0.53 ± 1.140	0.46	-0.144	0.886

*: The percentage of individuals who have experienced negative effects (choosing the "very often" or "often" option to think that the entry has a negative impact on the individual

In our project, the influencing factors of oral health-related quality of life were analyzed by multiple linear regression analysis, taking the total score of OHIP-14 as the dependent variable, and taking an anterior open bite, deep overbite, deep overjet, BMI index, and economic level as the independent variables (Table 7). Findings proved that anterior teeth open bite, deep overbite, and deep overjet affected the oral health-related quality of life, except for BMI index and economic level.

Table 7
Multiple linear regression analysis of influencing factors of oral health-related quality of life

Model 1				Model 2			
$R^2 = 0.038$	B	Beta	*p*	$R^2 = 0.031$	B	Beta	*p*
(Constant)	1.147	—	0.000	(Constant)	2.660	—	0.000
Anterior open bite	0.678	0.121	0.000	Anterior open bite	1.224	0.106	0.000
Deep overbite	0.066	0.049	0.022	Deep overbite	0.197	0.071	0.001
Deep overjet	0.354	0.117	0.000	Deep overjet	0.596	0.095	0.000
BMI index	-8.772	-0.022	0.307	BMI index	-3.598	-0.004	0.840
Economic level	-0.001	-0.001	0.980	Economic level	0.097	0.020	0.347
Dependent variable: Functional limitation				Dependent variable: Pain and discomfort			

Model 3				Model 4			
$R^2 = 0.040$	B	Beta	*p*	$R^2 = 0.070$	B	Beta	*p*
(Constant)	1.830	—	0.000	(Constant)	1.229	—	0.000
Anterior open bite	1.150	0.219	0.000	Anterior open bite	1.417	0.163	0.000
Deep overbite	0.151	0.062	0.004	Deep overbite	0.160	0.077	0.000
Deep overjet	0.704	0.127	0.000	Deep overjet	0.736	0.156	0.000
BMI index	-1.182	-0.016	0.452	BMI index	-8.020	-0.001	0.951
Economic level	0.123	0.029	0.177	Economic level	0.114	0.031	0.136
Dependent variable: Physical and mental disorders				Dependent variable: Ability disorder			

Model 5			
$R^2 = 0.053$	B	Beta	*p*
(Constant)	6.867	—	0.000
Anterior open bite	4.469	0.138	0.000
Deep overbite	0.537	0.074	0.001
Deep overjet	2.391	0.136	0.000
BMI index	-2.499	-0.011	0.613
Economic level	0.333	0.024	0.246
Dependent variable: Total score of quality of life			

Discussion

Selection of investigation methods and standards

There is no unified standard for the epidemiological investigation of malocclusion in the world. At present, the commonly used investigation standards include Angle's classification standard, Dental Aesthetic Index (DAI), and Index of Orthodontic Treatment Need (IOTN). The latter two are widely used in European and American countries. Taking into account the limitations of DAI and IOTN, and ensuring consistency with the standards of most studies at home and abroad, this survey used the Angle's classification as the standard that reduced the impact of the survey standards on the research results, and allowed the comparison with the results of local surveys.

Prevalence of malocclusion

In recent years, many investigations and studies have been published on the prevalence of malocclusion; some of which were related to the prevalence of malocclusion in children with mixed dentition. Perhaps due to the differences in race, geographical environment, eating habits, and economic status, the prevalence characteristics of malocclusion in the same age group are different in different regions and countries such as 46.5% in Japan [8], 83.3% in India [9], and 87% in Iran [10]. In China, Fu Minkui and others investigated in 2000 that the malocclusion of children in the period of mixed dentition stage was as high as 71.21% [3]. In the past decade, the survey results have been very different across the country, 79.40% in Shanghai [11], and 69.38% in Hailing District, Taizhou City [12].

The results of this survey showed that the prevalence rate of malocclusion in children aged 6–12 years old in Jinzhou was 67.90%, which belongs to a high level in foreign and domestic reports. The pathology and related factors of malocclusion are complex. It is known that genetic factors are highly correlated with craniofacial abnormalities [13]. In addition to genetic factors, environmental factors can also affect the normal development of occlusal. For example, finger sucking can cause anterior teeth to open bite [14]. This study found that the Angle class I malocclusion had the highest prevalence rate among all kinds of malocclusion, and dentition crowding was the most common clinical manifestation of all kinds of malocclusion, which was the same as that reported previosuly [11, 12, 15]. It can be seen that most of the malocclusion is dentition crowding in which the molar relationship is neutral, which is in line with the human evolutionary process of ethnic evolution, the masticatory organs are reduced and degenerated, and the degeneration of alveolus and jaws is faster than that of teeth. In addition, with the improvement of the level of modern food processing, the frequency of eating tough food is reduced, the jaws are not stimulated, and the number of teeth is greater than that of bone, resulting in dentition crowding. For example, the prevalence rates of malocclusion and dentition crowding in Tibetan [16] adolescents are lower than those in Han nationality, mainly because they eat beef, mutton, and other high toughness, crude fiber food and strong grinding food for a long time, which makes the degeneration of masticatory muscle and jaw more slowly, and the imbalance of tooth and bone mass is alleviated.

Differences of malocclusion in gender, age, nationality, urban and rural areas

This study showed that there was no significant difference in the prevalence rate of malocclusion between men and women, consistent with previous results [17]. Previous data indicate differences in the prevalence of malocclusion among different age groups; the prevalence rate increases with age. The prevalence rate of deciduous tooth stage is the lowest, followed by the period of mixed dentition stage, and the highest in the early stage of permanent dentition. Because the dentition of the selected samples in this study were in the mixed dentition stage, the final results showed that the prevalence rate of malocclusion was higher in children aged 6–8 years, and less in children aged 9–12 years old. This could be due to the fact that the children from 6–8 years old were in the early stage of mixed dentition. With the increase of age, the jaws continue to develop, and their length and width increase. It is beneficial to adjust the position of permanent teeth and improve the symptoms of malocclusion. There was no difference in

prevalence rate between urban and rural areas, which is consistent with the results of the recent survey [18]. With the improvement of people's living standards, the differences between the urban and rural areas are shrinking, and the dietary structure is gradually converging between urban and rural areas. Moreover, people's oral hygiene habits are also being strengthened. No matters in urban or rural areas, people pay more attention to oral health, especially children's dental health, and children's awareness of oral health care and medical treatment are increasing. In addition, there was no difference in the prevalence rate between different ethnic groups, which is different from some domestic research results [11, 18].

Manifestations of malocclusion in different categories

The malocclusion was divided into groups according to Angle classification, and the results showed that the highest prevalence rate of Angle class I was 46.48%, and that of Angle class II and III was 9.39% and 12.03%, respectively. The results were similar to the study of Brazilian [19] children. The results showed that Angle Class I was the main malocclusion, accounting for 35.89%, Angle Class II and Class III are basically the same, which are 5.82% and 6.36%, respectively. The differences between the results of each study may be due to differences in diagnostic criteria, race, age and lifestyle of the subjects. It should be noted that this survey takes individual normal occlusion as the judgment standard, and according to the national unified orthodontic textbooks, any slight deformities that do not interfere with the physiological process can be included in the category of normal occlusion, therefore, the judgment of individual normal occlusion and malocclusion will be affected by subjective factors, and the prevalence rate of each Angle classification may be distorted to a certain extent.

The survey found that the prevalence of dentition crowding was the highest among local abnormalities (71.79%), which was related to the unbalanced degenerative changes in the craniofacial region. Jaw degeneration is faster than teeth, resulting in tooth mass greater than bone mass. The result of this survey shows that the incidence of spacing is 12.07%. The gap in deciduous dentition and mixed dentition is beneficial to the eruption and establishment of permanent dentition, but it is found that 9 of the 16 subjects do not have deciduous tooth space, but their permanent dentition is not crowded, indicating that it may not be necessary to use developmental space and primate space to solve the problem of permanent dentition crowding. The relationship between crowding, spacing and malocclusion needs to be confirmed by other longitudinal data.

Compared with the national average level, Jinzhou children not only have a high prevalence of malocclusion, but also have complex and diverse types of malocclusion. The survey found that except for 694 (32.10%) individual normal occlusion, 8.14% of the children had only one malocclusion. Most children (47.46%) showed 2 or 4 malocclusion at the same time, and 12.30% of the children had 5 or more malocclusion types at the same time. Complex and diverse manifestations of malocclusion will increase the treatment difficulty of malocclusion and prolong the treatment time of malocclusion, which also calls for early prevention and treatment of malocclusion in children. At the same time, Jinzhou City should strengthen policy support and financial investment for the prevention and treatment of children's malocclusion.

With the eruption of the second molars and the growth and development of the mandibular ramus, the deep overbite can be relieved by itself [20]. Because there is no corresponding auxiliary examination means, we have included all the deep overbite into the category of malocclusion and increased the prevalence of deep overbite (39.32%). The vertical malocclusion also includes anterior edge-to-edge occlusion (4.02%) and open bite (2.08%). The prevalence of anterior edge-to-edge occlusion is similar to that of a survey in Xi'an [17], but lower than that of other foreign studies[21, 22] .

Deep overjet (8.93%) is the most common sagittal malocclusion. According to a morphological longitudinal study, with the increase of age, because the mandible grows forward more than the maxilla, deep overjet is likely to decrease [23]. The study found that the prevalence rate of anterior crossbite in children in Jinzhou is 9.62%. It will affect the growth of craniofacial region and have a certain effect on joints. With the increase of age, anterior crossbite will become more and more serious [24].

Malformed frenulum of lip mainly include low labial frenulum and short lingual frenulum. This examination found that the probability of abnormal frenulum in children in Jinzhou is 5.83%. Too low maxillary labial frenum will lead to scattered space between maxillary central incisors, and too short lingual frenulum will lead to mesial torsion of mandibular central incisor. The results showed that delayed loss of primary teeth was closely related to malocclusion ($p = 0.001$). The causes of deciduous tooth retention included pulp lesions of deciduous teeth or malposition of germs of succeeding permanent teeth, which makes the root of deciduous teeth stick to alveolar bone or slow absorption. Retention of deciduous teeth will lead to dislocation eruption or embedded impaction of succeeding permanent teeth, resulting in individual tooth crossbite and occlusal interference. Therefore, we suggest that parents should pay attention to the situation of children's replacement teeth. Daily diet should not be too fine, and when the eruption of permanent teeth is found, the retained deciduous teeth should be removed as soon as possible.

Analysis of risk factors related to malocclusion

It is believed in the existing literature that bad oral habits are closely related to the occurrence of malocclusion, and the prevalence rate of malocclusion in children with bad oral habits is higher than that in normal children. Bad habits such as lip biting, finger sucking and tongue sticking will lead to the occurrence of malocclusion such as tilted teeth, narrow dental arch, anterior teeth open bite and so on [25]. The results of this survey are similar, the prevalence rate of malocclusion in children with bad oral habits is higher than that in normal children, and the difference is statistically significant ($p > 0.05$). Higher frequency and duration of oral bad habits was associated with greater possibility of malocclusion. This study found that the habit of biting the lower lip increased the risk of deep overbite and increased the incidence of Angle II malocclusion. When biting the lower lip, the lower lip is located between the upper anterior teeth and the lower anterior teeth, which makes the upper anterior teeth tilted to the labial side and suppresses the lower anterior teeth to the lingual side, which is easy to make the lower dentition crowded and form a deep overjet in the anterior tooth area. Biting the lower lip restricts the development of the mandible and increases the occurrence of Angle II malocclusion. The habit of biting the upper lip

and protruding the mandible can easily lead to malocclusion of anterior crossbite and Angle III malocclusion. Its mechanism is opposite to that of lower lip bite, which can promote the growth of mandible forward, and is prone to malformations such as anterior crossbite; mandibular protrusion and mesial malocclusion.Oral breathing habits increased the deformities of deep overbite, anterior open bite and Angle II malocclusion. During oral breathing, the tongue is pulled downward, the strength of the tongue muscle to the upper dental arch is weakened, the strength of the buccal muscle to it is enhanced, and the internal and external muscle balance of the maxillary arch is lost, resulting in stenosis of the upper dental arch, protrusion of the upper anterior teeth, and deep overjet. In addition, during oral breathing, the mandible is usually in the backward position, which can cause mandibular retraction over a long time, and the molars are in distal relationships. Oral breathing continues to increase the facial height, the posterior teeth erupt excessively, and the mandible rotates backward and downward, resulting in the open bite and occlusion of the anterior teeth. When children prop up their cheeks to read and think, the occlusal, jaw and facial growth and development are subjected to abnormal external forces, which may lead to the occurrence of malocclusion. In this study, the habit of propping up cheeks can increase the prevalence of deep overbite. In addition, in the course of this study, it was found that retained deciduous teeth and low maxillary labial frenulum would lead to an increase in the prevalence of malocclusion, and low labial frenulum would increase the prevalence of space between maxillary central incisors.

It is not clear whether there is a correlation between dental caries and malocclusion. According to the cross-sectional study on the relationship between dental caries and malocclusion in children aged 6–12 years old in Jinzhou, it was found that there was a correlation between dental caries and malocclusion ($p < 0.05$).In addition, it is difficult to rule out the influence of genetic and other factors on malocclusion. Future epidemiological studies on malocclusion need a unified examination standard, a larger and more systematic sample size, and controlling other variables to analyze the relationship between a dependent variable and malocclusion.

A large number of studies have discussed the relationship between dental caries and malocclusion. Some scholars believe that dental caries is a risk factor for malocclusion. Because dental caries can change the height and width of the crown, cause dentition crowding and changes in occlusal surface, and affect joints. The incidence of malocclusion in children with deciduous teeth is 2.04 times higher than that in children without dental caries [5] .However, some scholars have pointed out that the occurrence of malocclusion is closely related to the time and severity of caries, and only the caries of mixed dentition and permanent dentition may lead to malocclusion [26]. This survey found that the prevalence of malocclusion is related to dental caries. The total prevalence rate of dental caries in children is as high as 61.05%, indicating that the oral health status of children in Jinzhou is poor and the awareness of health care is not enough. The prevalence rate of malocclusion in patients with dental caries was higher than that in normal subjects, independent of age, sex, area and other factors. It is well known that deciduous caries lead to reduction of mesial and distal crown diameter and early loss of dental caries, resulting in insufficient eruption space or abnormal eruption of inherited permanent teeth, which can cause dentition

crowding; extensive dental caries make oral mastication function insufficient, jaws can not get physiological stimulation, and can also cause malocclusion.

Effect of malocclusion on oral health-related quality of life

The term "quality of life" originates from the medical field and is defined as "people's perception of their status in life according to their goals, expectations, standards and concerns in the context of the culture and value system of their lives."Health-related quality of life is a term used to assess pain/discomfort and how physical, psychological and social functions affect well-being.The impact of oral health on quality of life is called oral health-related quality of life, which is defined as "symptoms, functions and psychosocial effects caused by oral diseases and disorders".

Previous studies have shown that malocclusion has a significant impact on children's oral function, oral symptoms, psychology, social contact and facial beauty.In 2010, Locker D et al [27] used the Children's perception questionnaire to study the oral function and psychology of 66 children aged 11 ~ 14 years old. The results showed that malocclusion had a significant impact on children's oral function and psychology. The results showed that the severity of malocclusion could affect most adolescents' self-perception of dental cosmetology. For example, domestic scholar ELYASKHIL M, SHAFAI N A A and MOKHTAR N [28] investigated and analyzed the malocclusion of 255 malay school children. The results showed that malocclusion can not only cause the disorder of children's masticatory system, but also affect children's facial beauty. It has an important impact on students' social communication and psychological behavior.

The Chinese version of OHIP-14 scale was used to evaluate oral health-related quality of life [6] .OHIP-14 measures the frequency of oral effects in seven conceptual areas, each with two problems, namely, functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability and handicap. The answer options were Likert scale: 0 = never, 1 = almost never, 2 = occasionally, 3 = often, 4 = very often. Add up the project scores to determine the total score. The sum of scores can range from 0 to 56. A score of zero (0) means no effect, while a score of 56 indicates the opposite, that is, oral health has the greatest impact on children's quality of life. The results of this survey showed that there was no difference in the scores of oral health-related quality of life among children aged 6 to 12 in Jinzhou city in terms of gender, age, nationality and socio-economic conditions ($p > 0.05$). This result is different from that of foreign studies [29]. The reason for the analysis may be due to different inclusion criteria, ethnic groups and children's living habits. The survey found that "physical pain" is the most common negative impact, accounting for 3.65%, followed by "psychological discomfort" is also a common occurrence in the population, accounting for 3.56%, the item with the least impact on individuals is "social disability", accounting for only 1.61%. However, on the whole, malocclusion has little effect on children's oral health-related quality of life, which may be due to the younger age, lower aesthetic requirements and less degree of malocclusion in the investigated children; it doesn't have a significant impact on the quality of life. In the course of this survey, the influencing factors of oral health-related quality of life were analyzed. OHIP-14 was divided into dependent variables, and multiple linear

regression analysis was conducted with anterior open bite, deep overbite, deep overjet, BMI index, economic level and other independent variables. Among them, anterior open bite, deep overbite and deep overjet had influence on oral health-related quality of life, while BMI index and economic level had no effect.

On the whole, malocclusion affected the oral health-related quality of life of children in Jinzhou, mainly in pain and psychology. In addition, multiple linear regression analysis found that anterior open bite, deep overbite, deep overjet were significantly associated with oral health related quality of life. The results of this survey showed that there was no difference in the scores of oral health-related quality of life among different genders, ages, nationalities, and socio-economic conditions. Since the severity of malocclusion was not classified by IOTN, it could be mainly considered that the overall prevalence of malocclusion of children in Jinzhou City is high, but the severity of malocclusion is relatively low, and hence, the impact on children is relatively small.

Conclusion

The prevalence rate of malocclusion in children aged 6 ~ 12 years old in Jinzhou was 67.90%, of which dentition crowding was the most common, with a prevalence rate of 71.79%, followed by deep overbite, anterior crossbite, scattered dentition in the space, deep overjet, anterior edge-to-edge occlusion, and anterior open bite. The malocclusion of children in Jinzhou is complex and diverse, and most children (47.46%) showed 2 or 4 kinds of malocclusion at the same time. The severe disease situation should attract the attention of health administrative departments, medical workers and parents. Binary logistic regression analysis was used to analyze the risk factors of malocclusion. The results showed that BMI index had little effect on the occurrence of malocclusion($p > 0.05$), while genetic factors, dental caries, bad oral habits, retained deciduous teeth and low labial ligature were all related to the occurrence of malocclusion ($p < 0.05$). The higher the frequency and duration of bad oral habits were associated with more possibility of malocclusion. As for the effect of malocclusion on oral health-related quality of life, the results showed that there was no difference in the scores of oral health-related quality of life among different genders, ages, nationalities, socioeconomic conditions and so on ($p > 0.05$).The survey found that "physical pain" is the most common negative impact, accounting for 3.65%, followed by "psychological discomfort" is also a common occurrence in the population, accounting for 3.56%, the item with the least impact on individuals is "social disability", accounting for only 1.61%.Through multiple linear regression analysis of oral health-related quality of life, it was found that anterior open bite, deep overbite and deep overjet had effects on oral health-related quality of life, while BMI index and economic level had no effect.

Declarations

Acknowledgements

Not applicable.

Authors' contributions

JH X contributed in the design of the study wrote the first draft of the manuscript, revised the manuscript, participated in data interpretation. XY L, SW L, and XQ W participated in acquisition of data. X L was major contributor in writing and revising of the manuscript, participated in data interpretation, and provided critical comments. J L participated in statistical analyses and interpretation. All authors read and approved the final manuscript.

Funding

This research received no specific grant from any funding agency in the pub- lic, commercial, or not-for-profit sectors.

Availability of data and materials

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

Ethics approval and consent to participate

The study protocol was designed in compliance with the Helsinki Declaration and approved by the Ethics Committee of the Second Affiliated Hospital of Jinzhou Medical University and the parents signed the informed consent.

Consent for publication

Not applicable.

Competing interests

The author declares that there are no competing interests.

References

1. Katz CRT, Rosenblatt A, Gondim PPC. Nonnutritive sucking habits in Brazilian children: effects on deciduous dentition and relationship with facial morphology. Am J Orthod Dentofacial Orthop 2004;126:53–57.
2. Martins- Júnior P A,Marques L S,Ramos-Jorge M L. Malocclusion: social, functional and emotional influence on children. The Journal of clinical pediatric dentistry, 2012, 37(1): 103–8.
3. Fu M, Zhang D, Wang B, Deng Y, Wang F, Ye X. **The prevalence of malocclusion in China-an investigation of 25,392 children**. Zhonghua Kou Qiang Yi Xue Za Zhi 2002;**37**:371–373.
4. Grippaudo C,Paolantonio E G,Antonini G, Saulle R, La Torre G, Deli R. Association between oral habits, mouth breathing and malocclusion. Acta otorhinolaryngologica Italica : organo ufficiale della

Societa italiana di otorinolaringologia e chirurgia cervico-facciale, 2016, 36(5): 386–94.

5. Martins MT, Sardenberg F, Bendo CB, Vale MP, Paiva SM, Pordeus IA. Dental caries are more likely to impact on children's quality of life than malocclusion or traumatic dental injuries. Eur J Paediatr Dent 2018;19:194–198.
6. Weini X, Lingjun J. Validation of a Chinese version of the oral health impact profile-14. Chinese Journal of Stomatology 2006;41:242–245.
7. Guarnizo-Herreño CC, Watt RG, Fuller E, Steele JG, Shen J, Morris S, Wildman J, Tsakos G. Socioeconomic position and subjective oral health: findings for the adult population in England, Wales and Northern Ireland. BMC Public Health 2014;14:827.
8. Motokawa M, Terao A, Kaku M, Kawata T, Gonzales C, Darendeliler MA, Tanne K. Open bite as a risk factor for orthodontic root resorption. Eur J Orthod 2013;35:790–795.
9. Cozza P, Mucedero M, Baccetti T, Franchi L. Early orthodontic treatment of skeletal open-bite malocclusion: a systematic review. Angle Orthod 2005;75:707–713.
10. Zuroff JP, Chen SH, Shapiro PA, Little RM, Joondeph DR, Huang GJ. Orthodontic treatment of anterior open-bite malocclusion: stability 10 years postretention. Am J Orthod Dentofacial Orthop 2010;137:302.e1-8; discussion 302-3.
11. Yu X, Zhang H, Sun L, Pan J, Liu Y, Chen L. Prevalence of malocclusion and occlusal traits in the early mixed dentition in Shanghai, China. PeerJ, 2019, 7:e6630.
12. Li W, Feng L, Tang B, Duan Y. Investigation of malocclusion and orthodontic treatment proportion of middle school students in Hailing district, Taizhou city. Shanghai Journal of Stomatology 2016;25:105–107.
13. Mossey PA. The heritability of malocclusion: part 2. The influence of genetics in malocclusion. Br J Orthod 1999;26:195–203.
14. Katz CRT, Aronita Rosenblatt A. Nonnutritive sucking habits and anterior open bite in Brazilian children: a longitudinal study. Pediatr Dent 2005;27:369–373.
15. Prabhakar RR, Saravanan R, Karthikeyan MK, Vishnuchandran C, Sudeepthi. Prevalence of malocclusion and need for early orthodontic treatment in children. J Clin Diagn Res 2014;8:ZC60–ZC61.
16. Yang Z L. Malocclusion prevalence among 3055 Tibetans in Lhasa. Zhonghua Kou Qiang Yi Xue Za Zhi 1988 Jul;23(4)
17. Zhou Z, Liu F, Shen S, Shang L, Shang L, Wang X. Prevalence of and factors affecting malocclusion in primary dentition among children in Xi'an, China. BMC Oral Health 2016;16:91.
18. Xiaojie D,Yinfeng Z,Ziwei L. Prevalence of malocclusion among 1022 Kazak junior school students: an epidemiological study. Shanghai Kou Qiang Yi Xue 2021 Jun;30(3)
19. de Freitas FCN, Bastos EP, Primo LS, de Freitas VL. Evaluation of the palate dimensions of patients with perennial allergic rhinitis. Int J Paediatr Dent 2001;11:365–371.

20. Baccetti T, Franchi L, McNamara JA Jr. Longitudinal growth changes in subjects with deepbite. Am J Orthod Dentofacial Orthop 2011;140:202–209.
21. Santos RR, Nayme JG, Garbin AJ, Saliba N, Garbin CA, MoHimaz SA. Prevalence of malocclusion and related oral habits in 5- to 6-year-old children. Oral Health Prev Dent 2012;10:311–318.
22. Laganà G, Masucci C, Fabi F, Bollero P, Cozza P. Prevalence of malocclusions, oral habits and orthodontic treatment need in a 7- to 15-year-old schoolchildren population in Tirana. Prog Orthod 2013;14:12.
23. Björk A, Skieller V. Normal and abnormal growth of the mandible. A synthesis of longitudinal cephalometric implant studies over a period of 25 years. Eur J Orthod 1983;5:1–46.
24. Trottman A, Elsbach HG. Comparison of malocclusion in preschool black and white children. Am J Orthod Dentofacial Orthop 1996;110:69–72.
25. Paolantonio EG, Ludovici N, Saccomanno S, La Torre G, Grippaudo C. Association between oral habits, mouth breathing and malocclusion in Italian preschoolers. Eur J Paediatr Dent 2019;20:204–208.
26. Singh A, Purohit B, Sequeira P, Acharya S, Bhat M. Malocclusion and orthodontic treatment need measured by the dental aesthetic index and its association with dental caries in Indian schoolchildren. Community Dent Health 2011;28:313–316.
27. Locker D, Jokovic A, Prakash P, Tompson B. Oral health-related quality of life of children with oligodontia. Int J Paediatr Dent 2010;20:8–14.
28. Elyaskhil M, Shafai N A A,Mokhtar N. Effect of malocclusion severity on oral health related quality of life in Malay adolescents. Health and quality of life outcomes, 2021, 19(1): 71.
29. Piassi E, Antunes LS, Graça TCA, Antunes LAA. The impact of mixed dentition malocclusion on the oral health-related quality of life for children and their families: A case-control study. J Clin Pediatr Dent 2019;43:211–217.

Figures

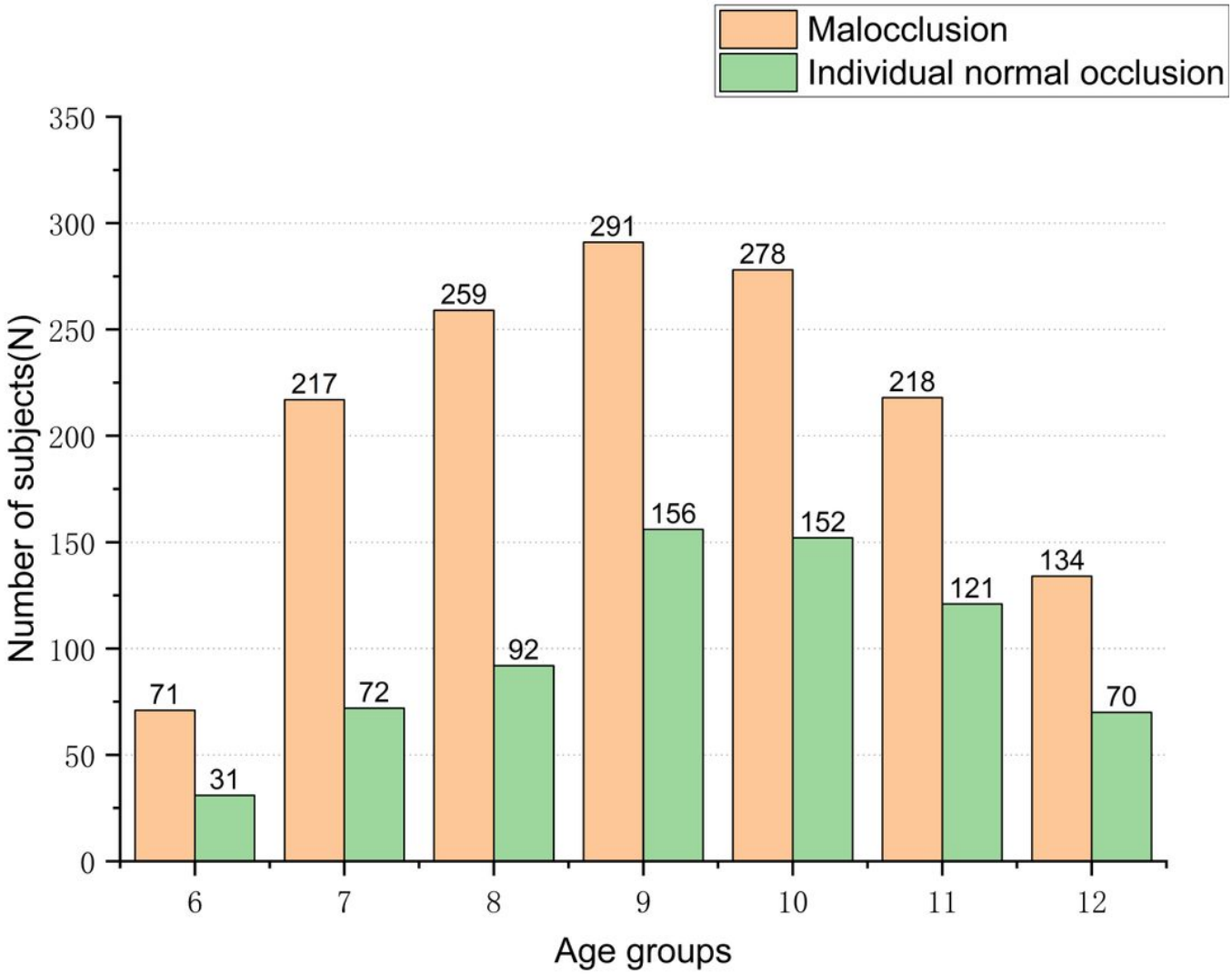

Figure 1

The composition of malocclusion at different ages of the surveyed subjects

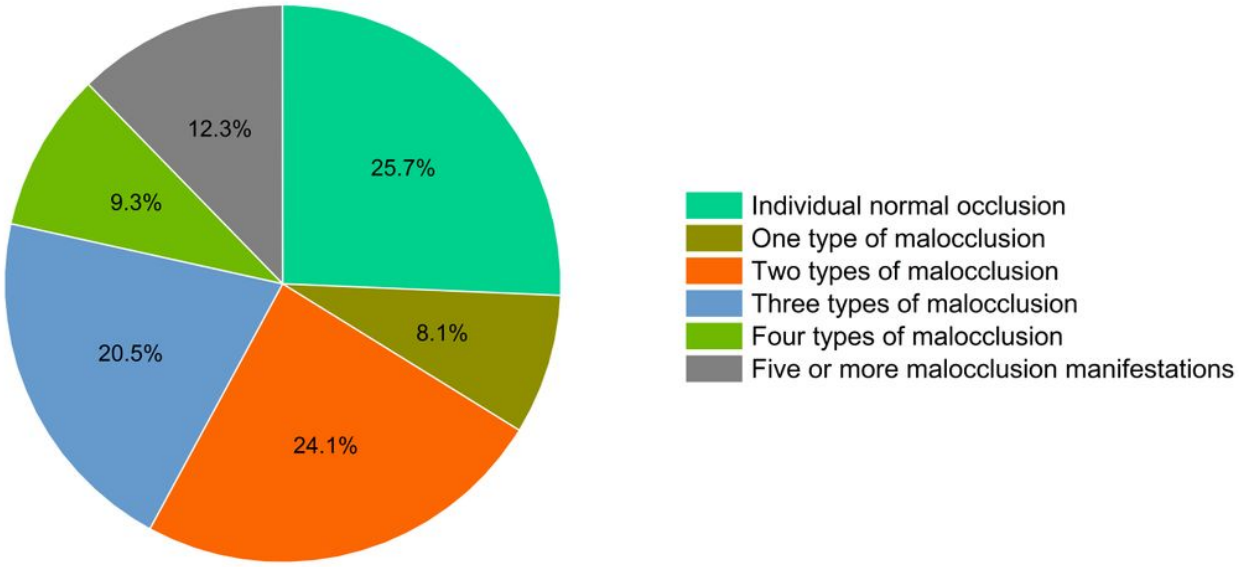

Figure 2

The severity of malocclusion in the subjects

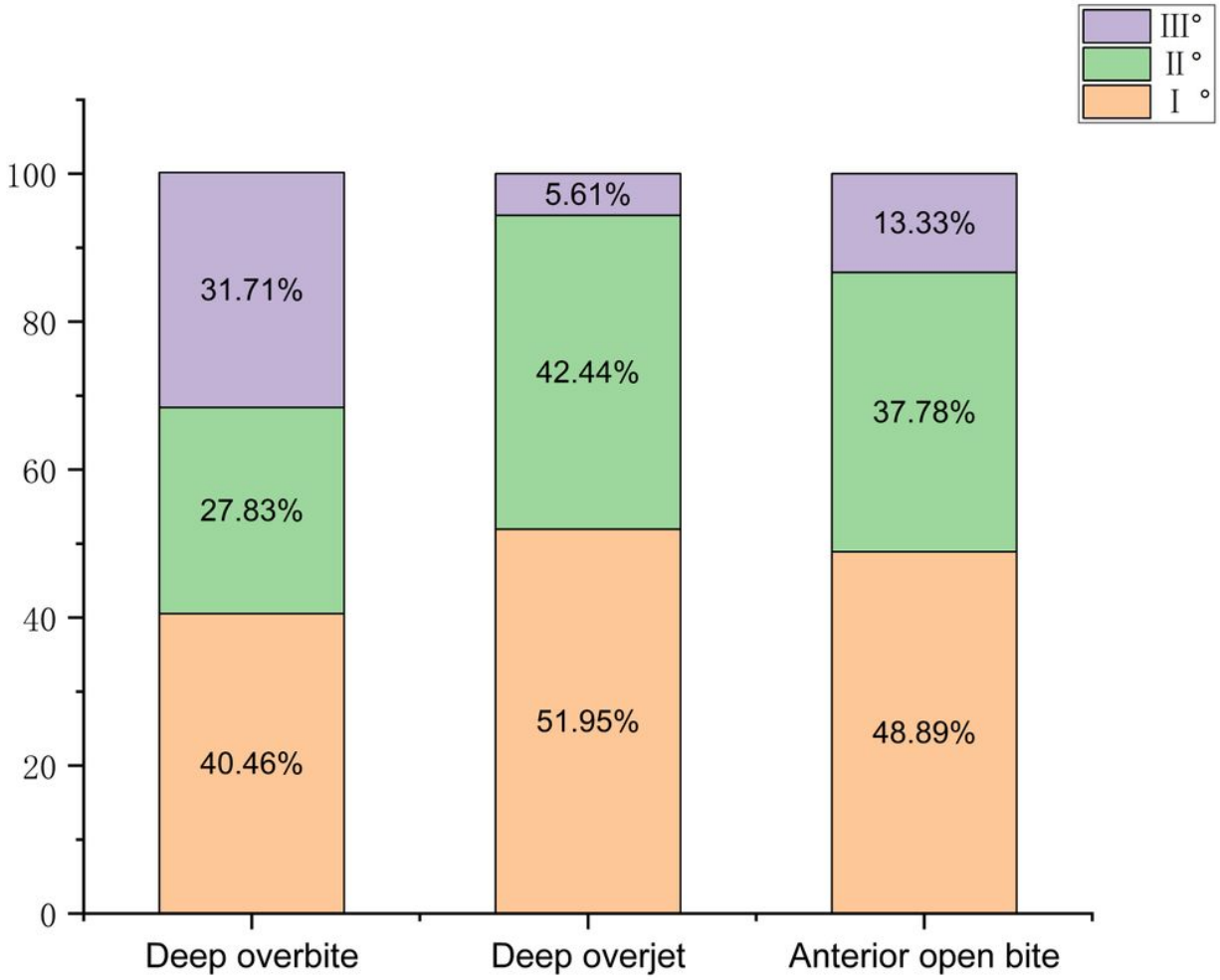

Figure 3

Composition of different degrees of deep overbite, deep overjet and anterior open bite

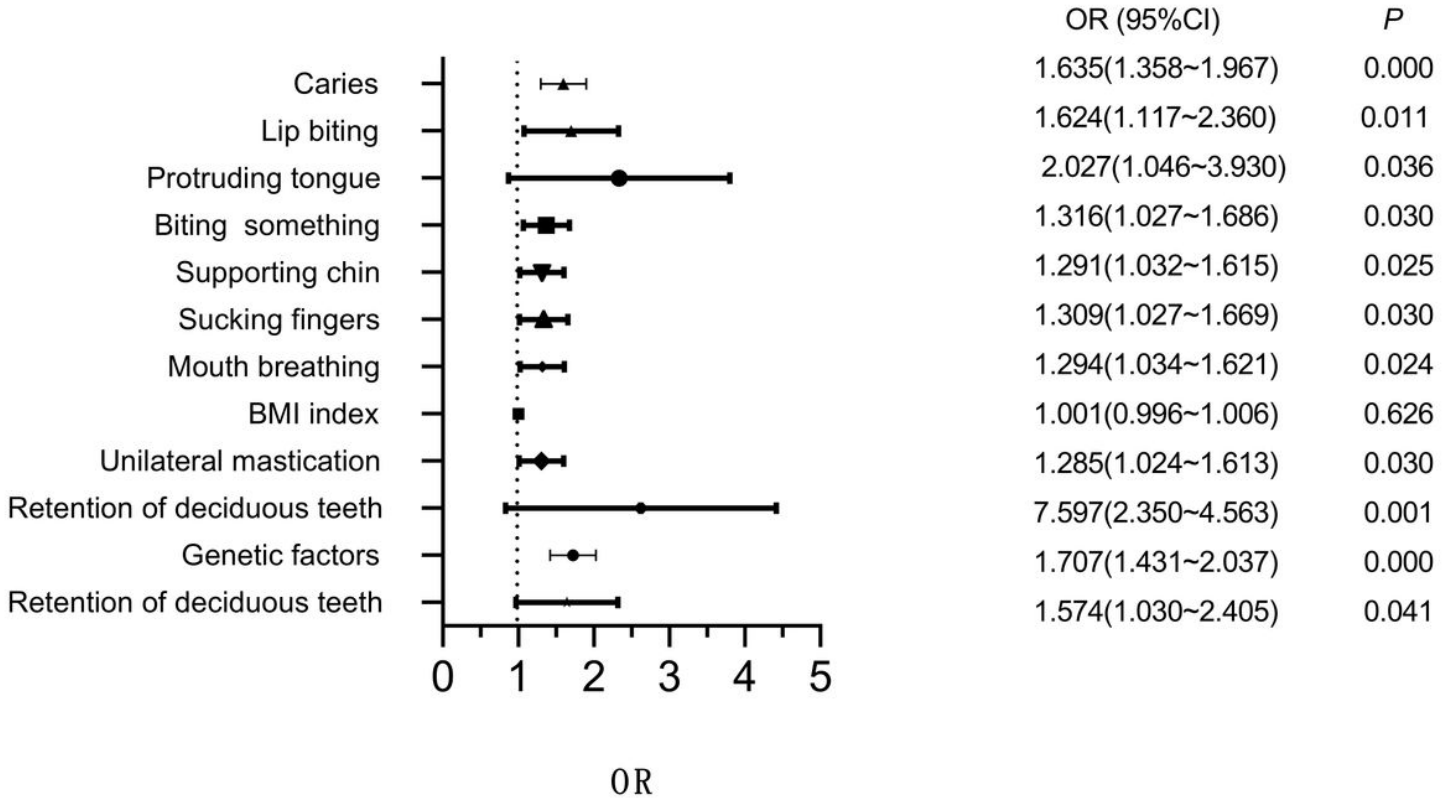

Figure 4

Visual analysis of risk factors of malocclusion by binary logistic regression