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Knowledge, attitude, and practice of adolescents and parents toward malocclusion and orthodontic treatment

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Malocclusion is the misalignment of teeth and jaws, affecting oral health and appearance. This study aimed to examine the knowledge, attitude, and practice (KAP) of both adolescents and parents toward malocclusion. This web-based cross-sectional study was conducted at Tianjin between July 2019 and July 2022, enrolled adolescents and their parents. The structural equation model (SEM) was used to analyze the interactions between KAP. A total of 478 adolescents and 380 parents were included. For knowledge, the scores were 6.95 ± 2.69 for adolescents and 7.07 ± 2.90 for parents (possible range, 0–12). For attitude, the scores were 36.96 ± 7.86 for adolescents and 33.26 ± 9.20 for parents (possible range, 13–65). For practice, the scores were 39.88 ± 7.85 for adolescents and 25.75 ± 8.56 for parents (possible range, 11–55). In parents, knowledge, practice, being a service personnel and production personnel, and acquiring knowledge through the Internet were associated with receiving orthodontic treatment. The SEM showed that knowledge directly affected attitudes ($\beta = 0.551$, $P < 0.001$) and practices ($\beta = 1.122$, $P < 0.001$). But attitudes did not affect practices ($\beta = -0.003$, $P = 0.923$). Adolescents and parents demonstrate unsatisfactory levels of knowledge, attitudes, and practices toward malocclusion. Improvements can be made by focusing on enhancing knowledge and encouraging proactive practices.

Keywords Knowledge, attitude and practice, Malocclusion, Adolescent, Parents, Orthodontics

Malocclusion is characterized by misalignment or improper positioning of the teeth. The prevalence of malocclusion worldwide is 56%[1]. In China, the overall prevalence stands at 47.92%[2]. This condition not only affects oral health and aesthetics but also has a significant impact on overall well-being and quality of life during adolescence[3]. Adolescents with malocclusion may experience difficulties with bite function and facial aesthetics, potentially leading to a reduced quality of life[4]. Early detection and intervention are essential for managing the functional and psychological impacts of malocclusion, underscoring the importance of timely orthodontic treatment[5].

The parents and adolescents play significant roles in treatment decisions and outcomes. Both of them are essential in understanding the awareness, beliefs, and behaviors towards malocclusion, which is crucial for effective orthodontic care[6]. However, there exists a knowledge gap in understanding adolescents' and their parents' attitudes, beliefs, and behaviors towards orthodontic treatment[7,8]. Assessing the Knowledge, Attitude, and Practice (KAP) of both adolescents and parents is essential in identifying barriers and facilitators in seeking orthodontic care. Understanding these factors can enhance treatment decisions and provide better guidance for interventions, ultimately leading to improved treatment outcomes.

Previous studies on KAP related to malocclusion and orthodontic treatment in adolescents and parents provide valuable insights[9]. Parents' oral health practices have the potential to influence the oral health of the next generation, underscoring the role of social support in shaping children's oral well-being[10]. However, these studies may have limitations, such as small sample sizes, specific geographical focuses, or insufficient inclusion of parental perspectives[9,11]. These limitations warrant a more extensive and inclusive study to provide a comprehensive understanding of the factors influencing orthodontic treatment decisions and experiences among adolescents and their parents.

This study was conducted in Tianjin, a major city in northern China known for its population of over 15 million and significant economic and medical development. A study conducted in March 2010 showed

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that, among 4,002 third-grade middle school students in Binhai New Area, Tianjin City, the prevalence of malocclusion was 36.86%[12]. The objective of this study is to investigate the KAP of both adolescents and parents toward malocclusion and orthodontic treatment. This study conducted a comprehensive KAP assessment among both adolescents and parents, filling existing gaps in understanding the factors influencing orthodontic treatment decisions and experiences, ultimately enhancing orthodontic care for this demographic.

Methods

Study design and participants

This cross-sectional study was conducted in Tianjin between July 2019 and July 2022 and enrolled adolescents and their parents. The study was approved by the Ethics Committee of Tianjin Beichen Hospital (2019050701), and all participants and their parents or legal guardians provided written informed consent.

The inclusion criteria were: (1) dolescents aged between 12 and 18 years old and at least one parent or guardian of each adolescent; (2) participants voluntarily participate in the study. The exclusion criteria were: (1) adolescents with congenital cleft lip and palate deformities; (2) adolescents with other severe facial aesthetic disorders. This includes congenital facial deformities such as cleft lip, cleft palate, facial clefts, hemifacial microsomia (first and second branchial arch syndrome); traumatic facial deformities such as severe facial fractures (zygomatic fractures, maxillary fractures, etc.), large areas of scarring; pathological facial deformities such as facial structure changes caused by tumors, facial deformities resulting from infections; and other severe facial deformities such as jaw deformities, severe dentofacial deformities, and facial nerve paralysis. The exclusion of this was evaluated by the researcher.

Questionnaire

The questionnaire was designed in Chinese, the native language of the participants, based on the literature and reviewed by 10 orthodontic experts[13,14]. Additionally, the questionnaire underwent a pilot test involving 91 parents and 143 adolescents, demonstrating Cronbach's α of 0.8995 and 0.8283, respectively, indicating good internal consistency. The English translation of the questionnaire was created for publication purposes but has not been validated in English-speaking populations.

The final questionnaire covers: demographics, knowledge, attitude, and practice. Demographics have 7 items for adolescents and 11 for parents (**Questionnaire-adolescent and Questionnaire-parents**). Knowledge has 12 questions, scored 1 for correct and 0 for incorrect answers, total range of 0–12. Attitude has 13 questions, rated on a 5-point Likert scale (1 to 5), total range 13–65. Practice includes 11 questions, on a 5-point Likert scale (1 to 5), total range of 11–55.

Both online and offline survey methods were employed. For the online survey, we utilized a reliable WeChat-based survey platform called "Questionnaire Star" (https://www.wjx.cn/). Participants were provided with a QR code distributed through WeChat, granting them convenient access to and completion of the questionnaire online. To ensure parental involvement, the QR code was shared during parent-teacher meetings at schools, facilitating parents' participation in filling out the online questionnaire. The offline questionnaires were administered on-site to guarantee that the adolescents themselves completed the survey.

Instead of relying on research assistants, the researcher personally handled the distribution and collection of all questionnaire data. Before collecting the questionnaires, a standardized explanation of the questionnaire's purpose and requirements was provided to all participants, ensuring a uniform understanding. Participants were required to answer all questions in the questionnaire, except for one particular question in the adolescent questionnaire that depended on their individual situation, specifically concerning ongoing orthodontic treatment. To encourage honest responses, the study assured anonymity and emphasized independent completion of the questionnaires by the participants. The researcher conducted thorough quality checks, promptly rectifying any errors or omissions.

Statistical analysis

Statistical analysis was performed using Stata 17.0 (Stata Corporation, College Station, TX, USA) and SPSS 22.0 (IBM Corp., Armonk, N.Y., USA). Continuous variables with normal distribution were expressed as mean ± standard deviation (SD) and compared using t-tests or analysis of variance (ANOVA). For skewed data, medians (Q1, Q3) were reported and compared using the Wilcoxon-Mann-Whitney or Kruskal-Wallis analysis of variance. Categorical variables were described using n (%). To ensure consistency in reporting, the mean was still used to evaluate the overall level of KAP, even for skewed data. Univariate and multivariate logistic regression analyses were conducted to identify factors associated with orthodontic treatment. In the multivariate regression analysis, variables with a P-value less than 0.05 in the univariate analysis were included. Structural equation modeling (SEM) was conducted to assess the hypotheses that knowledge directly affects attitudes and practices, and attitudes directly affect practices[10]. A two-sided $P < 0.05$ was considered statistically significant.

Results

Participant selection and analysis

A total of 528 questionnaires from adolescents were received. After excluding 39 completely duplicate questionnaires, 1 incompletely answered questionnaire, and 10 questionnaires with all KAP responses selected as option A. Finally, 478 valid questionnaires were analyzed (47.49% boys, 52.51% girls). A total of 421 questionnaires from parents were collected. After excluding 6 completely duplicate questionnaires, 5 questionnaires with all KAP responses selected as the same option, and 30 incompletely answered questionnaires, 380 valid questionnaires were analyzed (43.16% males, 56.84% females) (Tables 1 and 2).

Adolescent Questionnaire	N(%)	Knowledge Mean ± SD/ M (P_{25}, P_{75})	p	Attitude Mean ± SD/ M (P_{25}, P_{75})	p	Practice Mean ± SD/ M (P_{25}, P_{75})	p
Total	478	8 (5, 9)		36 (32, 41)		40 (35, 45)	
Age (years)			0.075		0.495		0.034
< 11	94(19.67)	8 (5, 9)		38 (33, 41.25)		40 (35.75, 44)	
11–15	226(47.28)	8 (6, 9)		36 (33, 44)		43 (37, 49)	
16–18	158(33.05)	8.5 (6, 9)		37 (32, 44)		41 (37.25, 46)	
Gender			0.415		0.830		0.638
Boy	227(47.49)	9 (6, 9)		36 (33, 44)		42 (36, 47)	
Girl	251(52.51)	8 (5.5, 9)		37 (33, 43.5)		42 (38, 46)	
Grade			0.039		0.223		0.187
Primary school	136(28.45)	7 (5, 9)		38 (34, 43)		39.00 ± 8.72	
Junior high school	204(42.68)	8 (6, 9)		36 (33, 41)		39.89 ± 7.88	
Senior high school	138(28.87)	9 (6.75, 9)		37 (32, 47)		40.74 ± 6.80	
Number of children in the family			0.255		0.033		0.256
1	274(57.32)	9 (6, 9)		36 (32, 41)		43 (37, 47)	
2	173(36.19)	8 (5.25, 9)		36 (33.25, 43.75)		41 (38, 45.75)	
≥ 3	35(6.49)	6 (3, 9)		39 (37.5, 47)		39 (33, 43.5)	
Received orthodontic treatment			0.002		0.194		< 0.001
Currently undergoing	113(23.64)	9 (6, 9)		37 (32, 44)		43 (38.5, 49)	
Completed	95(19.87)	8 (6, 9)		36 (33, 41)		41 (36, 45)	
Not received	270(56.49)	7 (5, 9)		36 (31, 41)		39 (32, 43)	
Person suggested that you receive orthodontic treatment			0.377		0.081		0.024
Family members	103(21.55)	8 (6, 9)		37 (33, 44)		42.03 ± 6.53	
Self-requested	55(11.51)	8 (6, 9)		38 (33, 40)		40.56 ± 7.16	
Doctor's recommendation	50(10.46)	9 (7, 9)		35.5 (26.75, 41.25)		43.74 ± 8.42	
Ways to acquire knowledge about orthodontic treatment			0.014		0.957		0.079
Doctor's education	165(34.52)	9 (6, 9)		36 (33, 44)		43 (36, 49)	
Parental explanation	146(30.54)	8 (5, 9)		37 (34, 43.5)		41 (38, 46)	
Classmate's promotion	63(13.18)	6 (4, 9)		39 (32, 45.5)		38 (34, 46)	
Internet	104(21.76)	9 (7, 9)		36 (32, 38)		41 (39, 46)	

Table 1. Baseline characteristics and KAP scores in adolescents.

KAP scores

For knowledge, the scores of adolescents and parents were 6.95 ± 2.69 and 7.07 ± 2.90 (possible range, 0–12). For attitudes, the scores were 36.96 ± 7.86 for adolescents and 33.26 ± 9.20 for parents (possible range, 13–65). For practices, the scores were 39.88 ± 7.85 for adolescents and 25.75 ± 8.56 for parents (possible range, 11–55) (Tables 1 and 2).

Regarding adolescents, those who had not received orthodontic treatment ($P = 0.002$) and acquired knowledge about orthodontic treatment from their classmates' promotion ($P = 0.003$) were more likely to have insufficient knowledge. Moreover, younger adolescents ($P = 0.034$), those who had not received orthodontic treatment ($P < 0.001$), self-requested orthodontic treatment ($P = 0.024$), and acquired knowledge about orthodontic treatment from their classmates' promotion ($P = 0.079$) appeared to have less proactive practices.

In parents, those who had a high school/vocational school education level ($P < 0.001$), were service personnel or production personnel ($P = 0.002$), had a monthly per capita income less than 5,000 CNY ($P < 0.001$), had a child who had not received orthodontic treatment ($P < 0.001$), and acquired knowledge about orthodontic treatment from the Internet ($P < 0.001$) were more likely to have insufficient knowledge. Parents who acquired knowledge about orthodontic treatment from parents of their child's classmates demonstrated less positive attitudes ($P = 0.003$). Furthermore, those who were not the child's parents ($P = 0.002$), were unit leaders or professional technical staff ($P = 0.028$), had a monthly per capita income between 5,000 and 10,000 ($P < 0.001$), and had a child who had completed orthodontic treatment ($P < 0.001$) appeared to have less proactive practices (Tables 1 and 2).

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Parent Questionnaire	N (%)	Knowledge Mean ± SD/ M (P_{25}, P_{75})	p	Attitude Mean ± SD/ M (P_{25}, P_{75})	p	Practice Mean ± SD/ M (P_{25}, P_{75})	p
Total	380	9 (8, 9.9)		39 (33, 46)		31 (26, 38)	
Age			0.373		0.639		0.771
26–30	48(12.63)	8 (6, 9)		31 (28, 39.75)		25.81 ± 9.90	
31–40	124(32.63)	8 (5.25, 9)		33 (29, 38)		26.33 ± 8.26	
41–50	133(35.00)	8 (6, 9)		33 (28, 39)		25.20 ± 7.82	
> 50	75(19.74)	8 (4, 9)		34 (27, 44)		25.72 ± 9.48	
Gender			0.960		0.566		0.401
Male	164(43.16)	8 (6, 9)		32 (27, 39)		25 (21, 30)	
Female	216(56.84)	8 (5, 9)		33 (29, 39)		26 (21, 31.75)	
Relationship to the child			0.090		0.252		0.002
Parent	333(87.63)	8 (6, 9)		33 (29, 39)		26 (21, 31)	
Other	47(12.37)	8 (5, 9)		30 (24, 42)		19 (15, 29)	
Residence			0.752		0.251		0.163
Rural	48(12.63)	7 (5.25, 9)		32 (27.5, 38.75)		23 (21.25, 32.25)	
Urban	258(67.89)	8 (6, 9)		34 (28, 40.25)		26 (19.75, 30.25)	
Suburban	74(19.47)	8 (4, 9)		31 (28.75, 36)		28 (20.25, 33.5)	
Education			< 0.001		0.122		0.742
Junior high school and below	47(12.37)	7 (5, 9)		32 (27, 39)		27 (20, 37)	
High school/vocational school	77(20.26)	7 (2.5, 9)		31 (26.5, 39)		25 (19, 33)	
College/undergraduate	163(42.89)	8 (6, 9)		33 (27, 38)		26 (19, 31)	
Master's and above	93(24.47)	9 (8, 9)		35 (29, 44)		26 (21.5, 29)	
Occupation			0.002		0.447		0.028
Unit leader and professional technical staff	170(44.74)	9 (7, 9)		33.5 (27, 42)		25 (19, 29)	
General staff	65(17.11)	8 (4, 9)		33 (30, 39)		27 (21.5, 32.5)	
Service personnel and production personnel	117(30.79)	8 (4.5, 9)		31 (27, 38)		27 (20.5, 33)	
Other	28(7.37)	7 (6, 9)		33 (31, 38.75)		28.5 (21.25, 37.75)	
Monthly per capita income, CNY			< 0.001		0.702		< 0.001
< 5,000	94(24.74)	6 (1, 9)		32 (29, 37)		28 (22, 38.25)	
5,000–10,000	148(38.95)	8 (6, 9)		32.5 (26, 38)		23.5 (19, 29)	
> 10,000	138(36.32)	9 (7.75, 9)		35 (28.75, 43)		26 (19, 30)	
Number of children in the family			0.894		0.594		0.265
1	233(61.32)	8 (5.5, 9)		33.31 ± 9.33		26 (21, 31.5)	
2	126(33.16)	8 (6, 9)		33.48 ± 9.07		26 (21, 31)	
≥ 3	21(5.53)	8 (6.5, 9)		31.29 ± 8.80		21 (17.5, 28.5)	
Child received orthodontic treatment			< 0.001		0.770		< 0.001
Currently underwent	82(21.58)	9 (8, 9)		34.5 (25.75, 42.5)		25 (16, 29)	
Completed	68(17.89)	8.5 (7, 9)		32 (27, 38.75)		23 (18, 26.75)	
Not received	230(60.53)	7 (4, 9)		32 (29, 39)		27 (21, 33)	
Ways to acquire knowledge about orthodontic treatment			< 0.001		0.003		0.091
Doctor's education	174(45.79)	9 (7.75, 9)		36 (27, 43)		26 (21, 29)	
Parents of child's classmates sharing	95(25.00)	8 (4, 9)		31 (27, 37)		26 (18, 33)	
Internet (such as WeChat, TikTok, Xiaohongshu, etc.)	111(29.21)	7 (5, 9)		31 (29, 36)		27 (21, 33)	

Table 2. Baseline characteristics and KAP scores in parents.

Comprehensive insights into KAP

In the knowledge dimension, the questions with the highest correct rates were '*Severe dental misalignment can affect overall facial growth and development, resulting in facial deformities such as "bimaxillary protrusion", "open bite" or "prognathism" exacerbating self-esteem issues.*' and *"Orthodontic treatment not only aligns teeth but can also improve facial structure and address functional problems caused by misalignment and malocclusion.*", with accuracy rates of 81.93% and 80.19% respectively. Only 6.64% of participants were aware that *"Invisible braces should be worn for no less than 18 hours per day"* (Table S1). In terms of attitudes, the statement *"I am well aware of the condition of my teeth, such as the type of malocclusion"* received the highest overall agreement, with approximately 65.97% of participants responding with either *"Strongly Agree"* or *"Agree"*. On the other hand, the statements *"I am concerned that the outcome of orthodontic treatment may not meet my expectations or*

relapse" and *"I believe that the cost of orthodontic treatment exceeds my budget"* received the lowest attitude scores, with only 15.03% and 15.96% of participants selecting either "Strongly Disagree" or "Disagree" (Table S2). In the practice dimension, the practice statement with the highest positive response rates, when considering the combined percentage of *"Very High/Always"* and *"High/Frequently"*, is *"Maintaining good oral hygiene (thoroughly brushing teeth, using dental floss, mouthwash, etc.",* receiving overall positive responses of 74.25%. Nevertheless, only approximately 57.46% of the participants proactively considered *"Using orthodontic wax or bite guards when necessary"* (Table S3).

Multivariate analysis

In adolescents, the multivariate regression analysis showed that knowledge score (OR = 1.092, 95% CI: 1.010–1.181, $P = 0.027$), practice score (OR = 1.065, 95% CI: 1.036–1.09, $P < 0.001$), and older age (11–15 years old: OR = 3.205, 95% CI: 1.408–7.293, $P = 0.006$; 16–18 years old: OR = 3.949, 95% CI: 1.311–11.895, $P = 0.015$) and acquiring knowledge about orthodontic treatment through the Internet (OR = 0.459, 95% CI: 0.268–0.786, $P = 0.005$) were associated with orthodontic treatment (Table 3). In parents, knowledge score (OR = 1.190, 95% CI: 1.058–1.338, $P = 0.004$), practice score (OR = 0.937, 95% CI: 0.904–0.972, $P = 0.001$), being a service personnel and production personnel (OR = 0.432, 95% CI: 0.218–0.855, $P = 0.016$), and acquiring knowledge about orthodontic treatment through Internet (OR = 0.216, 95% CI: 0.113–0.413, $P < 0.001$) were associated with orthodontic treatment (Table 4).

SEM analysis

To unveil the causal pathway relationships within knowledge, attitudes, and practices, we conducted SEM analysis. The results showed that knowledge directly affected attitudes ($β = 0.551$, $P < 0.001$) and practices ($β = 1.122$, $P < 0.001$). But attitudes did not affect practices ($β$ = -0.003, $P = 0.923$) (Fig. 1 and Table 5).

Discussion

The study revealed that adolescents had insufficient knowledge (mean score: 6.95 ± 2.69, 57.92% of the total score), negative attitudes (mean score: 36.96 ± 7.86, 56.86% of the total score), and moderate practices (mean score: 39.88 ± 7.85, 72.51% of the total score) towards malocclusion. Similarly, parents exhibited insufficient knowledge (mean score: 7.07 ± 2.90, 58.92% of the total score), negative attitudes (mean score: 33.26 ± 9.20, 51.17% of the total score), and poor practices (mean score: 25.75 ± 8.56, 46.82% of the total score). These insights highlight the significance of enhancing knowledge, attitudes, and practices related to malocclusion, which could potentially boost treatment acceptance and foster improved oral health outcomes in adolescents, thus contributing to the advancement of orthodontic care and oral health education.

Adolescents	Univariate analysis		Multivariate analysis	
	OR (95%CI)	*p*	OR (95%CI)	*p*
Knowledge	1.144 (1.065–1.229)	< 0.001	1.092 (1.010–1.181)	0.027
Attitude	1.024 (1.001–1.048)	0.044	1.025 (0.999–1.051)	0.065
Practice	1.069 (1.042–1.096)	< 0.001	1.065 (1.036–1.094)	< 0.001
Age				
< 11	ref		ref	
11–15	2.506 (1.453–4.322)	0.001	3.205 (1.408–7.293)	0.006
16–18	4.114 (2.323–7.285)	< 0.001	3.949 (1.311–11.895)	0.015
Gender				
Male	1.324 (0.921–1.903)	0.129		
Female	ref			
Grade				
Primary school	ref		ref	
Junior high school	1.444 (0.918–2.272)	0.111	0.697 (0.343–1.418)	0.319
Senior high school	2.629 (1.609–4.294)	< 0.001	1.012 (0.357–2.867)	0.982
Number of children in the family				
1	ref			
2	0.750 (0.509–1.103)	0.144		
≥ 3	0.836 (0.394–1.773)	0.640		
Ways to acquire knowledge about orthodontic treatment				
Doctor's education	ref		ref	
Parental explanation	0.643 (0.411–1.008)	0.054	0.654 (0.403–1.062)	0.086
Classmate's promotion	0.448 (0.244–0.822)	0.010	0.548 (0.283–1.062)	0.075
Internet	0.538 (0.326–0.888)	0.015	0.459 (0.268–0.786)	0.005

Table 3. Univariate and multivariate logistic regression analysis in adolescents.

Parents	Univariate analysis		Multivariate analysis	
	OR (95%CI)	*p*	OR (95%CI)	*p*
Knowledge	1.344 (1.126–1.486)	<0.001	1.190 (1.058–1.338)	0.004
Attitude	1.003 (0.981–1.026)	0.778	ref	
Practice	0.932 (0.907–0.958)	<0.001	0.937 (0.904–0.972)	0.001
Age				
26–30	ref			
31–40	1.089 (0.548–2.163)	0.808		
41–50	1.175 (0.596–2.317)	0.641		
>50	0.993 (0.470–2.099)	0.985		
Gender				
Male	1.107 (0.731–1.676)	0.632		
Female ref	ref			
Relationship to the child				
Parent ref	ref		ref	
Other	0.547 (0.278–1.075)	0.080	0.516 (0.217–1.228)	0.135
Residence				
Rural	0.349 (0.166–0.730)	0.005	0.436 (0.182–1.041)	0.062
Urban	ref		ref	
Suburban	0.853 (0.503–1.447)	0.556	1.522 (0.782–2.961)	0.216
Education				
Junior high school and below ref	ref		ref	
High school/vocational school	0.884 (0.397–1.970)	0.763	0.599 (0.223–1.608)	0.309
College/undergraduate	1.447 (0.718–2.915)	0.301	0.469 (0.177–1.244)	0.128
Master's and above	3.123 (1.478–6.598)	0.003	0.667 (0.224–1.990)	0.468
Occupation				
Unit leader and professional technical staff	ref		ref	
General staff	0.359 (0.194–0.662)	0.001	0.639 (0.294–1.386)	0.257
Service personnel and production personnel	0.313 (0.188–0.521)	<0.001	0.432 (0.218–0.855)	0.016
Other	0.411 (0.176–0.961)	0.040	0.852 (0.280–2.591)	0.778
Monthly per capita income, CNY				
<5,000	ref		ref	
5,000–10,000	1.444 (0.811–2.569)	0.212	0.779 (0.387–1.568)	0.484
>10,000	3.682 (2.077–6.527)	<0.001	1.757 (0.845–3.653)	0.131
Number of children in the family				
1ref	ref			
2	1.294 (0.834–2.009)	0.250		
≥3	0.506 (0.179–1.428)	0.198		
Ways to acquire knowledge about orthodontic treatment				
Doctor's education ref	ref		ref	
Parents of child's classmates sharing	0.413 (0.246–0.693)	0.001	0.652 (0.355–1.197)	0.168
Internet	0.160 (0.090–0.285)	<0.001	0.216 (0.113–0.413)	<0.001

Table 4. Univariate and multivariate logistic regression analysis in parents.

In this study, more than 50% of participants agreed that the cost of orthodontic treatment exceeded their budget, indicating financial challenges. Similarly, another study found that lower- and middle-income groups were more likely to choose to wait for free public orthodontic treatment, even in urgent cases, due to financial limitations[15]. The positive correlation between the Gini index and orthodontic use in children implies that higher costs act as a barrier for parents seeking orthodontic treatment for their children[16]. Additionally, in the US, cost emerged as the primary obstacle for orthodontic care for both functional and appearance-related reasons[17]. These findings highlight the significant impact of financial constraints on accessing orthodontic treatment and underscore the importance of addressing affordability concerns to ensure equitable access for all individuals. It was recommended, based on the local setting, to implement subsidized orthodontic programs or provide financial assistance to lower-income families, which could alleviate these barriers and improve access to treatment.

Retainers are recommended for long-term wear after orthodontic treatment to prevent the high likelihood of tooth movement relapse[18]. Despite this, adherence to retention varies due to factors such as inconvenience, discomfort, practical issues, and a lack of motivation or understanding of the importance of retainers[19,20]. The
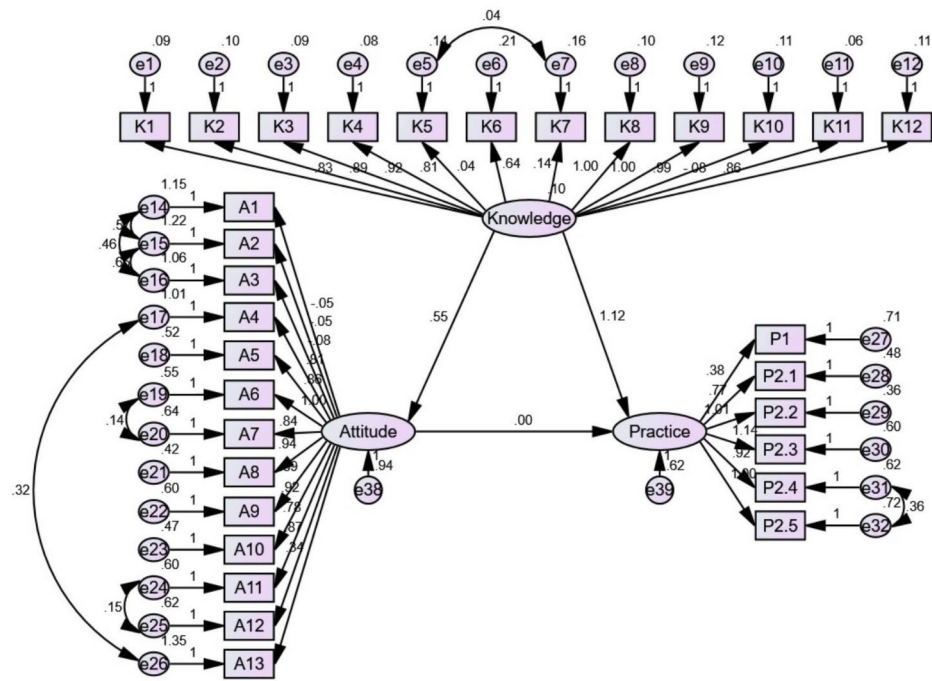
Fig. 1. SEM.

Path			β	P
Attitude	<---	Knowledge	0.551	< 0.001
Practice	<---	Knowledge	1.122	< 0.001
Practice	<---	Attitude	-0.003	0.932

Table 5. SEM path.

results of the present study revealed that 76.11% of participants demonstrated a high level of knowledge toward the necessity of retainers. However, attitudes towards consistent wear were less positive. Interestingly, despite these attitudes, average adherence to wearing retainers was relatively high. Previous studies have demonstrated that the level of knowledge toward retainer wear upon completion of treatment can range from 45.7 to 80.9%[9,21]. The results of our study fall within this range, reinforcing the understanding that knowledge doesn't directly translate to positive attitudes or adherence. The results of our study fall within this range, reinforcing the understanding that knowledge doesn't directly translate to positive attitudes or adherence. This issue could be addressed by implementing post-treatment follow-up programs, where orthodontists regularly check retainer use and provide education to reinforce the importance of adherence.

Social media impact orthodontics by allowing patients to share their experiences and opinions, seek advice, and access information about orthodontic treatment[22,23]. In the study, acquiring knowledge about orthodontic treatment through the Internet was found to be negatively associated with treatment receipt in both adolescents and their parents. This finding suggests that relying solely on Internet sources for orthodontic knowledge may influence the participants' decision-making process and potentially dissuade them from pursuing treatment. A previous study on YouTube videos also revealed limited informational value and inadequate representation of the orthodontic profession, which could have contributed to the negative association[24]. Given the widespread use of the internet as a primary information source, it is crucial for orthodontists to recognize and address the potential impact of online content, ensuring that accurate and reliable information is accessible to adolescents and their parents. In the local setting, implementing policies that encourage collaboration between orthodontists and social media platforms to provide verified, educational content could help counteract misinformation and guide patients towards informed decisions.

The multivariate logistic regression analysis revealed that higher knowledge and practice scores, as well as older age, were associated with an increased likelihood of receiving orthodontic treatment in adolescents. Similarly, higher knowledge scores in parents were associated with higher treatment likelihood. In line with this, the SEM analysis confirms that higher knowledge scores positively affected attitudes and practices. Studies have shown that orthodontic treatment is influenced by socioeconomic status, parental education, geography, occupation, insurance, patient age and gender, treatment need, and patient or parental perceptions, with

more affluent, educated families in urban areas with professional occupations generally more likely to seek treatment[25–28]. Additionally, the desire for orthodontic treatment among adolescents can be influenced by specific malocclusions, parental perception of the need for treatment, and the cost of the treatment[29,30]. In the local context, implementing school-based dental health programs that provide free or low-cost orthodontic consultations and financial assistance for families with lower socioeconomic status could help address these barriers and increase treatment access.

The limitations of the study include the sample size, which may limit the generalizability of the findings. Additionally, the study relied on self-reported data, which may be subject to recall bias or social desirability bias. Furthermore, the study focused on a specific population and geographic area, which may restrict the applicability of the results to other contexts. It is important to consider these limitations when interpreting the findings.

In conclusion, the study findings revealed unsatisfactory levels of knowledge, attitudes, and practices toward malocclusion among adolescents and parents. The findings highlight the importance of considering these factors when planning orthodontic interventions and improving patient education.

Data availability
All data generated or analyzed during this study are included in this article and supplementary information files.

References
1. Stomatologic, S. Worldwide prevalence of malocclusion in the different stages of dentition: A systematic review and meta-analysis. *Eur. J. Pediatr. Dentistry*. **21**, 115 (2020).
2. Lin, M., Xie, C., Yang, H., Wu, C. & Ren, A. Prevalence of malocclusion in Chinese schoolchildren from 1991 to 2018: A systematic review and meta-analysis. *Int. J. Pediatr. Dent*. **30**, 144–155 (2020).
3. Amuasi, A. A. et al. Effect of malocclusion on quality of life among persons aged 7–25 years: A cross-sectional study. *J. Biosci. Med*. **8**, 26 (2020).
4. Perkovic, V. et al. Facial aesthetic concern is a powerful predictor of patients' decision to accept orthognathic surgery. *Orthod. Craniofac. Res*. **25**, 112–118 (2022).
5. Talpos, S. et al. (eds) *Age-Related Quality of Life and Psychosocial Impact of Chin Asymmetry in Adolescents and Young Adults Undergoing Orthodontic and Orthognathic Correction* (Multidisciplinary Digital Publishing Institute, 2023).
6. Nobre, R. & Pozza, D. H. Parental influence in orthodontic treatment: A systematic review. *Med. Pharm. Rep*. **96**, 28–34 (2023).
7. Aiuto, R. et al. What do mothers (or caregivers) know about their children's oral hygiene? An update of the current evidence. *Children*. **9**, 1215 (2022).
8. Prado, L. H. et al. Adolescents' perception of malocclusion, their motivations, and expectations concerning the orthodontic treatment. Is it all about attractiveness? A qualitative study. *Am. J. Orthod. Dentofac. Orthop*. **161**, e345–e352 (2022).
9. Mathew, R., Sathasivam, H. P., Mohamednor, L. & Yugaraj, P. Knowledge, attitude and practice of patients towards orthodontic treatment. *BMC Oral Health*. **23**, 132 (2023).
10. Zheng, S. et al. Relationship between oral health-related knowledge, attitudes, practice, self-rated oral health and oral health-related quality of life among Chinese college students: A structural equation modeling approach. *BMC Oral Health*. **21**, 1–11 (2021).
11. Ghonmode, S., Shrivastava, S., Kadaskar, A. R. & Bapat, S. Socioeconomic burden of orthodontic treatment: A systematic review. *Med. Pharm. Rep*. **96**, 154 (2023).
12. Hu, Y. X., Wu, H. M., Hu, F. X., Cao, Y. & Yan, X. P. Investigation of 4002 cases of malocclusion of middle school students in Binhai New Area of Tianjin. *Stomatology*. **31**, 622–623 (2011).
13. Ganapathi, A. & Jeevanandan, G. Parental awareness about malocclusion in their children in Chennai population. *Int. J. Pharm. Res*. **12**, 2669–2681 (2020).
14. Büyükbayraktar, Z. Ç. & Doruk, C. Evaluation of knowledge, approaches, and self-efficacy perceptions of Turkish dental students about preventive and interceptive orthodontic applications in 2018–2019. *J. Oral Health Oral Epidemiol*. **10**, 202–208 (2021).
15. Almarhoumi, A. et al. Parental knowledge and practice regarding their children's malocclusion and Orthodontic Care in Al-Madinah, Saudi Arabia: A cross-sectional study. *J. Oral Health Comm. Dent*. **16**, 57 (2022).
16. Simon, L. et al. Association of income inequality with orthodontic treatment use. *J. Am. Dent. Association*. **151**, 190–196 (2020).
17. Chambers, D. W. & Zitterkopf, J. G. How people make decisions about whether or not to seek orthodontic care: Upstream in the treatment chain. *Am. J. Orthod. Dentofac. Orthop*. **155**, 826–831 (2019).
18. Abdulraheem, S., Schütz-Fransson, U. & Bjerklin, K. Teeth movement 12 years after orthodontic treatment with and without retainer: Relapse or usual changes? *Eur. J. Orthod*. **42**, 52–59 (2020).
19. Frawley, T., Parkin, N., Kettle, J., Longstaff, S. & Benson, P. Young people's experiences of orthodontic retainers: A qualitative study. *J. Orthodont*. **49**, 394–402 (2022).
20. Al-Moghrabi, D., Colonio Salazar, F. B., Johal, A. & Fleming, P. S. Factors influencing adherence to vacuum-formed retainer wear: A qualitative study. *J. Orthodont*. **46**, 212–219 (2019).
21. Negi, N., Malhotra, B. V. K., Jhingta, A. & Sharma, P. K. Knowledge, attitude and practice of patients undergoing fixed orthodontic treatment in Shimla, Himachal Pradesh: A questionnaire survey. *J. Research: BEDE ATHENAEUM*. **9**, 1–8 (2018).
22. Papadimitriou, A., Kakali, L., Pazera, P., Doulis, I. & Kloukos, D. Social media and orthodontic treatment from the patient's perspective: A systematic review. *Eur. J. Orthod*. **42**, 231–241 (2020).
23. Graf, I. et al. Social media and orthodontics: A mixed-methods analysis of orthodontic-related posts on Twitter and Instagram. *Am. J. Orthod. Dentofac. Orthop*. **158**, 221–228 (2020).
24. Guo, J. et al. Quantitative and qualitative analyses of orthodontic-related videos on YouTube. *Angle Orthod*. **90**, 411–418 (2020).
25. Felemban, O. M., Alharabi, N. T., Alamoudi, R. A., Alturki, G. A. & Helal, N. M. Factors influencing the desire for orthodontic treatment among patients and parents in Saudi Arabia: A cross-sectional study. *J. Orthodontic Sci*. **11**, (2022).
26. Oh, M. H., Park, A. H., Kim, M., Kim, E. A. & Cho, J. H. Part II. What drives Korean adults to seek orthodontic treatment: Factors contributing to orthodontic treatment decisions. *Korean J. Orthod*. **51**, 3–14 (2021).
27. Ajwa, N. et al. (eds) *The Influence of Orthodontic Treatment Need on Oral Health-Related Quality of Life among 12–18-Year-Old Adolescents in Riyadh* (MDPI, 2022).
28. Ramos, I. T. et al. Correlation between malocclusion and history of bullying in vulnerable adolescents. *Angle Orthod*. **92**, 677–682 (2022).
29. Brumini, M. et al. Parental influence is the most important predictor of child's orthodontic treatment demand in a preadolescent age. *Odontology*. **108**, 109–116 (2020).

30. Isnaini, K. S., Sari, G. D. & Wibowo, D. Differences in the psychosocial statuses of treated and non-treated adolescents with orthodontic treatment. *Dentino: Jurnal Kedokteran Gigi.* **7**, 39–43 (2022).

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Author contributions
Dongni Liu and Hongbin Li carried out the studies, participated in collecting data, and drafted the manuscript. Dongni Liu and Hongbin Li performed the statistical analysis and participated in its design. Dongni Liu and Hongbin Li participated in acquisition, analysis, or interpretation of data and draft the manuscript. All authors read and approved the final manuscript.

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Declarations

Competing interests
The authors declare no competing interests.

Ethics approval and consent to participate
This work has been carried out in accordance with the Declaration of Helsinki (2000) of the World Medical Association. This study was approved by the Ethics Committee of Tianjin Beichen Hospital (2019050701), and all participants and their parents or legal guardians provided written informed consent.

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