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Knowledge, attitude, and practice toward oral health management among orthodontic patients: a cross-sectional study

Jianping Zhao¹, Ai Cao¹, Linjun Xie² and Lei Shao^{3*}

Abstract

Background This study aimed to investigate the knowledge, attitude, and practice (KAP) toward oral health management among orthodontic patients.

Methods A cross-sectional study on orthodontic patients was conducted at Suzhou Dushu Lake Hospital from December 20, 2023, to March 19, 2024. Demographic data and KAP scores were collected using self-designed questionnaires. The cutoff for adequate KAP dimension scores was 70%.

Results The study included 418 orthodontic patients, of whom 274 (65.55%) were female, and 144 (34.45%) were male. The average age was 32.70 ± 8.47 years (33.72 ± 8.46 in females and 32.17 ± 8.44 in males). The mean knowledge, attitude, and practice scores were 11.80 ± 4.06 (possible range: 0–16), 27.00 ± 3.18 (possible range: 6–30), and 31.13 ± 6.01 (possible range: 8–40), respectively. The proportions of participants who scored above a cutoff of 70% were 247 (59.09%) for knowledge, 403 (96.41%) for attitude, and 290 (69.38%) for practice. Multivariate logistic regression showed that knowledge score (OR = 1.243, 95% CI: [1.152–1.342], $P < 0.001$), attitude score (OR = 1.255, 95% CI: [1.140–1.381], $P < 0.001$), and wearing an appliance for 3 to 6 months (OR = 4.309, 95% CI: [1.565–11.861], $P = 0.005$) were independently linked to proactive practice. Structural equation modeling demonstrated that knowledge directly influenced attitude ($\beta = 0.684$, $P < 0.001$) and practice ($\beta = 0.527$, $P < 0.001$), while attitude had a direct impact on practice ($\beta = 0.587$, $P < 0.001$).

Conclusions The majority of orthodontic patients demonstrated adequate knowledge, positive attitudes, and proactive practices toward oral health management. Nonetheless, continuous education is still essential for certain groups, such as recently fitted orthodontic patients, to ensure sustained improvement in oral health outcomes.

Keywords Knowledge, Attitude, Practice, Oral health management, Patient

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Background

Oral health is a crucial aspect of overall well-being, contributing significantly to general health [1]. According to the World Health Organization's definition, good oral health encompasses the well-being of the oral cavity and related tissues, characterized by the absence of gingival bleeding, xerostomia, tooth loss, periodontal diseases, and other oral disorders [2]. In recent years, there has



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been a noticeable increase in the proportion of adults seeking orthodontic treatment [3], possibly related to a shift from a negative to a positive attitude over the past two decades [4]. However, orthodontic therapy often leads to an increase in cariogenic bacterial growth due to biofilm buildup, challenges in maintaining oral hygiene, and reduced self-cleaning mechanisms of the oral cavity [5, 6]. Therefore, effective oral hygiene is imperative to prevent caries and periodontal diseases during orthodontic treatment. To achieve optimal plaque control in orthodontic patients, the use of toothbrushes and complementary tools such as dental floss, single-tufted brushes, interdental brushes, and mouthwash is highly recommended [7, 8]. Dental floss is particularly important to remove the plaque between teeth and near the gums [9]. Disclosing agents for staining dental deposits (e.g., Tri Plaque or erythrosine) can also be used to visualize the quality of tooth cleaning [10, 11]. Despite these measures, plaque control remains challenging due to patients' inadequate brushing skills and insufficient cooperation, particularly among those with fixed appliances. Oral hygiene deteriorates in about 40%–60% of patients' during orthodontic treatment [12–14] and 5%–10% of treatments will fail because of improper oral hygiene [15].

The Knowledge, Attitude, and Practice (KAP) survey serves as a valuable diagnostic tool for understanding a group's comprehension, beliefs, and behaviors on specific topics, particularly within health literacy. This is based on the concept that knowledge positively influences attitude, which then shapes behaviors [16, 17]. In the context of oral health, greater knowledge promotes awareness of its importance and ultimately leads to improved oral health [18, 19]. Previous studies support that enhanced oral health knowledge is linked to better outcomes and encourages individuals to practice oral self-monitoring procedures [20–22].

Compared with the general population, orthodontic patients have an increased risk of oral health issues [12–14], resulting in a higher prevalence of dental caries and periodontal diseases [23, 24]. Despite the importance of oral hygiene, many orthodontic patients struggle to maintain proper hygiene due to inadequate awareness or a lack of proper guidance. Therefore, understanding the KAP of these patients is vital because these factors directly influence their oral health outcomes during treatment.

Current research on oral health management knowledge among orthodontic patients often emphasizes fundamental and technical aspects of orthodontic treatment [25, 26], with limited studies focusing on specific content and methods for managing oral health. Therefore, this study aims to investigate KAP toward oral health

management among orthodontic patients during their treatment.

Methods

Study design and participants

This cross-sectional study included patients undergoing orthodontic treatment at Suzhou Dushu Lake Hospital from December 20, 2023, to March 19, 2024. Ethical approval for the study was granted by the Ethics Committee of the Fourth Affiliated Hospital of Soochow University (Approval No: 231007), and informed consent was obtained from all participants.

The inclusion criteria for this study were as follows. 1) Patients must be receiving their first orthodontic treatment for permanent dentition. 2) Individuals must have been wearing orthodontic appliances, such as brackets and aligners, for at least 3 months. 3) Patients must be adults aged 18 years or older. The exclusion criteria were: 1) patients experiencing other concurrent oral diseases, 2) those requiring additional oral surgical treatments, 3) patients with severe systemic diseases or complications that might interfere with the treatment or survey results, or 4) Patients who are unable to understand or independently respond to the questionnaire.

Questionnaire

The questionnaire was designed using established guidelines, including the "*Guidelines for clear aligner orthodontic treatment (2021)*" [27] and pertinent literature [28]. Prior to the formal study, a preliminary survey was conducted with 30 patients to refine the questionnaire and establish its reliability and validity. This preliminary phase resulted in an overall Cronbach's α coefficient of 0.8803, indicating good reliability.

The finalized questionnaire, presented in Chinese, was structured into four sections: demographic information (including age, gender, education level, monthly income, orthodontic method, and duration of appliance wear), knowledge dimension, attitude dimension, and practice dimension (Additional file 1). The knowledge dimension comprised 8 items, with responses graded as "very familiar" (2 points), "heard of" (1 point), and "not clear" (0 points), allowing for a total score ranging from 0 to 16 points. The attitude dimension included 6 items on a five-point Likert scale varying from "strongly agree" (5 points) to "strongly disagree" (1 point), resulting in a total score range of 6 to 30 points. The practice dimension included 10 items. Items P1–P8 utilized a Likert scale format, with responses ranging from "Never" (1 point) to "Always" (5 points), resulting in a total possible score ranging from 8 to 40 points. Items P9 and P10 were multiple-choice questions that were neutral in nature and not related to either positive or negative inclination; they were intended

solely for descriptive analysis. Achieving scores above 70% of the maximum possible in each section was considered indicative of adequate knowledge, positive attitude, and proactive practice [29].

Questionnaire distribution and quality control

An online questionnaire was developed using the Sojump platform (<https://www.wjx.cn/>), and a QR code was generated for data collection through WeChat. Participants scanned the QR code to log in and complete the questionnaire. To ensure the quality and completeness of the responses, each IP address was allowed only one submission, and all items were mandatory. If participants encountered any issues while answering, members of the research group were available to interpret and resolve problems. All questionnaires were reviewed for completeness, consistency, and validity by the research team members.

Sample size

The formula

$$n = \left(\frac{Z_{1-\alpha/2}}{\delta} \right)^2 \times p \times (1 - p)$$

was used to calculate the sample size of cross-sectional surveys. In the formula, n represents the sample size for each group, α represents the type I error (which is typically set at 0.05), $Z_{1-\alpha/2} = 1.96$, δ represents the allowable error (typically set at 0.05), and p is set at 0.5 (as setting it at 0.5 maximizes the value and ensures a sufficiently large sample size). Hence, the calculated sample size was 384.

Statistical analysis

Statistical analysis was conducted using SPSS 26.0 (IBM Corp., Armonk, N.Y., USA) and AMOS 24.0 (IBM Corp., Armonk, N.Y., USA). The normality of continuous variables was verified using the Kolmogorov–Smirnov test. Continuous variables that adhered to a normal distribution were expressed as mean \pm standard deviation (SD) and analyzed using the Student's t -test for two-group comparisons or ANOVA for more than two groups. Skew-distributed variables were presented as medians and ranges and analyzed using the Wilcoxon–Mann–Whitney U -test for two groups or the Kruskal–Wallis test for more than two groups. Categorical variables were described as n (%) and examined using the chi-square test. Pearson correlation analysis was utilized to evaluate the relationships among KAP scores. In the multivariate analysis, a cutoff value was set at 70% of the total score for including variables in logistic regression. Variables achieving a p -value of less than 0.05 in univariate analyses were subsequently included in multivariate regression

analyses. Hypotheses were tested through structural equation modeling (SEM), examining the direct and indirect effects of knowledge on attitude and practice. The fit of the models was assessed using the root mean square error of approximation (RMSEA), Chi-Square/degrees of freedom ratio (CMIN/DF), incremental fit index (IFI), Tucker-Lewis index (TLI), and comparative fit index (CFI). A two-sided p -value of less than 0.05 was considered statistically significant.

Results

Among the 418 orthodontic patients who participated in this study, 274 (65.55%) were females, and 144 (34.45%) were male, with a mean age of 32.70 ± 8.47 years (33.72 ± 8.46 in females and 32.17 ± 8.44 in males). Among the 418 participants, 374 (89.47%) were residing in urban areas, 200 (47.85%) had a bachelor's degree, 267 (63.88%) were orthodontically corrected by fixed bracket treatment, and 93 (22.25%) had worn the appliance for more than 2 years. Among all participants, the mean knowledge, attitude, and practice scores were 11.80 ± 4.06 (possible range: 0–16), 27.00 ± 3.18 (possible range: 6–30), and 31.13 ± 6.01 (possible range: 8–40), respectively. The proportions of participants who scored above a cutoff of 70% were 247 (59.09%) for knowledge, 403 (96.41%) for attitude, and 290 (69.38%) for practice. Patients who had different durations of appliance wear were more likely to have different knowledge, attitudes, and practice scores (all of $P < 0.001$). Patients with different gender (both of $P < 0.001$) and orthodontic modalities ($P = 0.003$ and $P = 0.020$) were more likely to have different knowledge and attitude scores (Table 1).

The distribution of knowledge dimension revealed that the question with the highest number of participants choosing the "Very familiar" option was "Fixed orthodontic appliances can easily lead to food residue accumulation. Therefore, besides brushing teeth in the morning and evening, it is also advisable to clean the mouth promptly after meals." (K4), with 63.16%. The question with the highest number of participants choosing the "Unclear" option was "Post-orthodontic patients require special oral health management." (K1), with 14.11% (Table S1).

When it comes to attitudes related to oral health management in orthodontic treatment, 61.72% strongly agreed that it is important (A1), and 58.85% strongly agreed that patients should receive professional management guidance (A4). Then, 42.58% were concerned about other oral diseases due to inadequate care (A5), and 40.67% agreed that postoperative patients should have regular follow-up visits to check their oral health (A3) (Table S2).

Table 1 Demographic characteristics and KAP scores of participants

	N (%)	Knowledge, mean ± SD	P	Attitude, mean ± SD	P	Practice, mean ± SD	P
Total	N=418	11.80±4.06		27.00±3.18		31.13±6.01	
Gender			<0.001		<0.001		0.079
Male	144 (34.45)	10.69±4.20		26.04±3.49		30.26±6.46	
Female	274 (65.55)	12.38±3.87		27.51±2.89		31.58±5.73	
Age	32.70±8.47						
Residence			0.052		0.181		0.912
Rural	44 (10.53)	10.34±5.09		26.25±3.59		30.52±7.74	
Urban	374 (89.47)	11.97±3.90		27.09±3.13		31.20±5.79	
Education			0.198		0.327		0.143
College and below	86 (20.57)	12.19±4.12		26.69±3.66		31.85±6.56	
Bachelor's degree	200 (47.85)	11.80±4.20		27.22±3.13		31.14±6.07	
Master's degree and above	132 (31.58)	11.54±3.81		26.89±2.92		30.65±5.55	
Average monthly income, yuan			0.478		0.404		0.790
<5000	77 (18.42)	11.79±4.26		26.86±4.00		31.05±6.83	
5000–10000	134 (32.06)	12.06±4.06		27.25±2.88		30.89±6.02	
10,000–20000	127 (30.38)	11.44±3.93		26.70±3.06		31.08±5.93	
>20,000	80 (19.14)	11.93±4.12		27.21±2.98		31.69±5.34	
Orthodontic Method			0.003		0.020		0.373
Fixed bracket treatment	267 (63.88)	12.28±3.76		27.24±3.24		31.34±5.98	
Aligner treatment	151 (36.12)	10.93±4.42		26.59±3.05		30.76±6.07	
Duration of Appliance Wear			<0.001		<0.001		<0.001
<3 months	116 (27.75)	9.18±4.50		25.58±3.34		28.73±6.63	
3–6 months	52 (12.44)	11.50±3.86		26.98±2.87		32.38±5.07	
6–12 months	67 (16.03)	12.90±3.36		27.22±2.75		31.97±5.83	
1–2 years	90 (21.53)	13.06±3.32		27.87±2.41		32.06±5.24	
More than 2 years	93 (22.25)	13.22±3.05		27.80±3.52		31.91±5.81	

Responses to the practice dimension showed that 48.09% always insisted on brushing their teeth in the morning and evening, and after meals (P4.1), 46.65% always went to the hospital for regular follow-ups as prescribed (P1). Meanwhile, 36.36% often received management guidance and performed oral management (P2), 36.36% often paid attention to diet and avoided hard or sticky food (P4.4). Additionally, only 28.23% sometimes used mouthwash (P4.3) (Table S3).

Regarding the factors affecting oral health management, 58.85% of the patients reported cumbersome procedures and lack of time, followed by 47.61% due to pain or discomfort caused by orthodontic appliances (Figure S1A). When it comes to the sources of knowledge of oral health management, 83.49% of the patients reported that it was from hospitals or medical staff, followed by 51.44% from new media (Figure S1B).

Correlation analysis for the full group showed that there were significant positive correlations between knowledge and attitude ($r=0.611$, $P<0.001$) as well as practice ($r=0.560$, $P<0.001$). Also, there was a

correlation between attitude and practice ($r=0.557$, $P<0.001$) (Table 2).

Multivariate logistic regression showed that being male (OR=0.475, 95% CI: [0.301–0.748], $P=0.001$), wearing appliance less than 3 months (OR=0.160, 95% CI: [0.084–0.305], $P<0.001$), and wearing appliance for 3 to 6 months (OR=0.389, 95% CI: [0.186–0.815], $P=0.012$) were independently associated with adequate knowledge (Table 3). Concurrently, knowledge score (OR=1.243, 95% CI: [1.152–1.342], $P<0.001$), attitude score (OR=1.255, 95% CI: [1.140–1.381], $P<0.001$), and wearing appliance for 3 to 6 months (OR=4.309, 95% CI: [1.565–11.861], $P=0.005$) were independently associated

Table 2 Correlation analysis

	Knowledge	Attitude	Practice
Knowledge	1		
Attitude	0.611 ($P<0.001$)	1	
Practice	0.560 ($P<0.001$)	0.557 ($P<0.001$)	1

Table 3 Univariate and multivariate analysis for knowledge dimension

	Univariate logistic regression		Multivariate logistic regression	
	OR (95%CI)	P	OR (95%CI)	P
Gender				
Male	0.398 (0.263–0.602)	< 0.001	0.475 (0.301–0.748)	0.001
Female	ref		ref	
Age				
	0.986 (0.964–1.009)	0.231		
Residence				
Rural	ref			
Urban	1.363 (0.729–2.552)	0.332		
Education				
College and below	ref			
Bachelor's degree	0.889 (0.528–1.496)	0.658		
Master's degree and above	0.733 (0.421–1.278)	0.274		
Average monthly income				
< 5000	ref			
5000–10000	1.195 (0.674–2.118)	0.543		
10,000–20000	0.873 (0.493–1.548)	0.643		
> 20,000	1.067 (0.564–2.016)	0.843		
Orthodontic Method				
Fixed bracket treatment	1.684 (1.123–2.525)	0.012	1.134 (0.714–1.799)	0.594
Aligner treatment	ref		ref	
Duration of Appliance Wear				
< 3 months	0.134 (0.072–0.249)	< 0.001	0.160 (0.084–0.305)	< 0.001
3–6 months	0.335 (0.162–0.690)	0.003	0.389 (0.186–0.815)	0.012
6–12 months	0.728 (0.358–1.479)	0.380	0.905 (0.435–1.883)	0.790
1–2 years	0.903 (0.460–1.769)	0.765	0.903 (0.457–1.783)	0.768
More than 2 years	ref		ref	

with proactive practice (Table 4). Additionally, a gender-based subgroup analysis was further conducted. In the univariate analysis, wearing an appliance for less than 3 months (OR=0.171, 95% CI: [0.081–0.362], $P<0.001$) was significantly associated with adequate knowledge among females (Table S4). For males, having a Master's degree or higher (OR=0.252, 95% CI: [0.083–0.765], $P=0.015$), wearing orthodontic appliances for less than 3 months (OR=0.090, 95% CI: [0.026–0.313], $P<0.001$), or for 3 to 6 months (OR=0.242, 95% CI: [0.063–0.940], $P=0.040$) were independently associated with adequate knowledge (Table S5). Additionally, knowledge score (OR=1.151, 95% CI: [1.036–1.278], $P=0.009$) and attitude score (OR=1.226, 95% CI: [1.070–1.404], $P=0.003$) were independently associated with proactive practices in men, while for women, knowledge score (OR=1.282, 95% CI: [1.166–1.411], $P<0.001$) and attitude score (OR=1.259, 95% CI: [1.109–1.429], $P<0.001$) showed similar associations (Table S6, S7).

The fit indices of the SEM model for the full group reached the desired range, indicating excellent model fit results (Table 5), and SEM results show that knowledge

directly affected attitude ($\beta=0.684$, $P<0.001$), and attitude directly affected practice ($\beta=0.587$, $P<0.001$), as well as the knowledge directly affected practice ($\beta=0.527$, $P<0.001$) (Table S8 and Fig. 1).

Discussion

The majority of orthodontic patients demonstrated adequate knowledge, positive attitudes, and proactive practices toward oral health management. Given the significant influence of knowledge on attitude and practice, continuous education remains necessary in specific groups, such as recently fitted orthodontic patients.

In examining both the significant differences observed among various demographic and treatment groups and the results of the multivariate logistic regression, several noteworthy findings emerge. Firstly, the gender disparities in knowledge and attitude toward oral health management among orthodontic patients are striking. The univariable analyses for knowledge, along with the multivariate analysis for knowledge, suggested that the female patients had higher levels of knowledge and more positive attitudes compared to their male counterparts. This

Table 4 Univariate and multivariate analysis for practice dimension

	Univariate logistic regression		Multivariate logistic regression	
	OR (95%CI)	P	OR (95%CI)	P
Knowledge score	1.316 (1.235–1.404)	< 0.001	1.243 (1.152–1.342)	< 0.001
Attitude score	1.406 (1.295–1.527)	< 0.001	1.255 (1.140–1.381)	< 0.001
Gender				
Male	0.713 (0.463–1.097)	0.124		
Female	ref			
Age	1.018 (0.992–1.044)	0.174		
Residence				
Rural	ref			
Urban	0.944 (0.477–1.871)	0.870		
Education				
College and below	ref			
Bachelor's degree	0.674 (0.376–1.208)	0.186		
Master's degree and above	0.567 (0.306–1.048)	0.070		
Average monthly income				
< 5000	ref			
5000–10000	0.763 (0.418–1.394)	0.379		
10,000–20000	1.077 (0.578–2.006)	0.816		
> 20,000	1.197 (0.596–2.403)	0.614		
Orthodontic Method				
Fixed bracket treatment	1.089 (0.708–1.676)	0.697		
Aligner treatment	ref			
Duration of Appliance Wear				
< 3 months	0.422 (0.235–0.758)	0.004	1.529 (0.724–3.226)	0.265
3–6 months	1.757 (0.749–4.119)	0.195	4.309 (1.565–11.861)	0.005
6–12 months	1.001 (0.493–2.033)	0.998	1.342 (0.590–3.055)	0.483
1–2 years	1.136 (0.585–2.208)	0.706	1.242 (0.580–2.662)	0.577
More than 2 years	ref		ref	

Table 5 SEM model fit

Model 1	Ref	Measured results
CMIN/DF	1–3 excellent, 3–5 good	2.961
RMSEA	< 0.08 good	0.069
IFI	> 0.8 good	0.934
TLI	> 0.8 good	0.924
CFI	> 0.8 good	0.933

aligns with existing literature suggesting that females tend to be more health-conscious and engaged in oral health behaviors [30]. The association between shorter durations of appliance wear and lower knowledge levels is also notable. This finding underscores the importance of providing comprehensive education and support to orthodontic patients from the outset to ensure optimal oral health outcomes throughout the treatment process [31].

Furthermore, the results of multivariate logistic regression analysis highlight the independent associations of gender and duration of appliance wear with knowledge levels. The negative association between male gender and knowledge levels underscores the importance of tailoring educational interventions to address the unique needs and preferences of male patients to improve their understanding of oral health management practice. Additionally, the significant predictive power of knowledge and attitude scores, along with the duration of appliance wear, in determining proactive practice underscores the need for holistic approaches to patient education and engagement. These findings emphasize the importance of fostering positive attitudes and beliefs about oral health among orthodontic patients, as they play a crucial role in translating knowledge into actionable behaviors [32].

Moving on to the correlation analyses and SEM results, the strong positive correlations observed between knowledge, attitude, and practice underscore the interconnectedness of these domains in influencing oral health

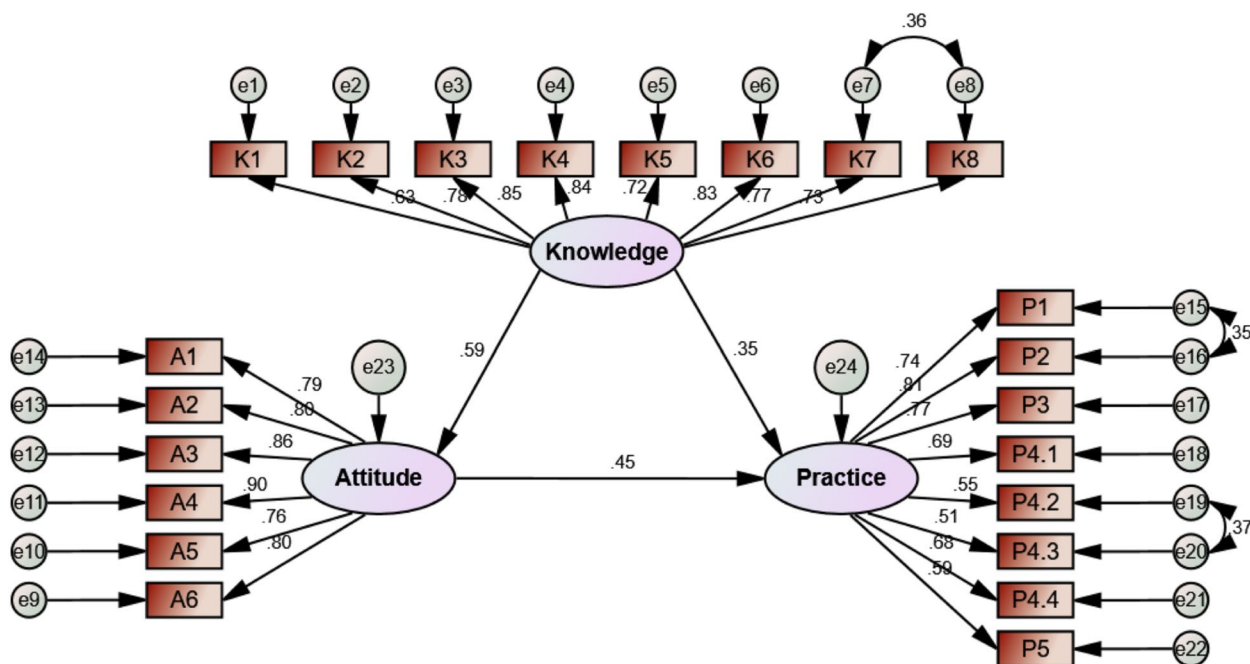


Fig. 1 SEM for KAP

behaviors among orthodontic patients. This finding supports the theoretical framework of the Health Belief Model, which posits that individuals’ personal belief influences their behavior [33]. The SEM results further elucidate the pathways through which knowledge and attitude influence practice, highlighting the direct impact of knowledge on attitude and practice, as well as the mediating role of attitude in translating knowledge into action. These findings underscore the importance of addressing knowledge gaps and fostering a positive attitude toward oral health management to promote sustained behavior change among orthodontic patients.

The results indicate a generally good level of knowledge about basic principles during orthodontic treatment, with the highest familiarity noted for the importance of brushing teeth. This high awareness mirrors findings in similar studies, emphasizing that brushing is universally recognized as the cornerstone of oral hygiene. In contrast, there is lower familiarity with the more specific impacts of neglecting oral hygiene, such as the risk of gingivitis and dental caries post-treatment. This discrepancy suggests that while basic knowledge is well disseminated, there is a gap in understanding the long-term consequences of poor oral health management. Educational campaigns could benefit from focusing more on the long-term consequences of neglecting oral hygiene during orthodontic treatment. Additionally, utilizing visual aids that depict the progression of dental issues could enhance understanding and retention of this knowledge.

Offering interactive sessions with dental professionals, where patients can ask questions and receive immediate feedback, may also help bridge the knowledge gap [34, 35].

Attitudes toward oral health management are generally positive, with a strong consensus on its importance during orthodontic treatment. However, there appears to be less certainty about the necessity for regular follow-up appointments, as shown by a lower degree of agreement compared to other statements about oral health management. The failure to enforce proper hygiene principles may undermine the effects of orthodontic treatment due to the necessity of reconstructive treatment for teeth, which affects their aesthetics. To improve the perceived importance of regular follow-ups, dental practice could implement reminder systems via digital platforms like SMS or email, which have been shown to be effective in other healthcare settings [36, 37]. Creating a personalized follow-up schedule that patients receive at the start of their treatment might also reinforce the necessity of these appointments.

In terms of practice, while many respondents report regularly brushing their teeth, there is notably less adherence to using dental floss and mouthwash. This indicates a potential lack of skill or motivation to engage in comprehensive oral care routines. The least adherence is observed in the use of mouthwash, which may be due to misconceptions about its benefits or the perceived extra effort involved. To encourage more comprehensive oral

care practice, it would be beneficial for orthodontic clinics to provide practical demonstrations on how to effectively use dental floss and mouthwash during regular appointments [38]. Additionally, distributing starter kits that include these items could increase utilization rates. For more persistent engagement, introducing a reward system for consistent use, monitored through a mobile app, could motivate patients to maintain comprehensive oral hygiene practice [39, 40].

While this study provides valuable insights into the knowledge, attitude, and practice of orthodontic patients concerning oral health management during treatment, several limitations should be acknowledged. Firstly, the cross-sectional design limits the ability to establish causal relationships between variables. Secondly, the study was conducted at a single center, which may restrict the generalizability of the findings to other populations or settings. Thirdly, the reliance on self-reported data via questionnaires introduces the possibility of response bias and social desirability bias, potentially impacting the accuracy of the results. Fourthly, the smaller sample sizes for men and women reduced the statistical power for conducting gender-specific subgroup analyses. In future studies, the comparison of declarative responses with practical applications through clinical research should be considered, with larger and more balanced sample sizes.

Conclusions

In conclusion, the majority of orthodontic patients demonstrated adequate knowledge, positive attitudes, and proactive practices toward oral health management. Continuous education remains necessary in specific groups, such as recently fitted orthodontic patients.

Abbreviations

KAP	Knowledge, attitude, and practice
SD	Standard deviation
SEM	Structural equation modeling
RMSEA	Root mean square error of approximation
CMIN/DF	Chi-square/degrees of freedom ratio
IFI	Incremental fit index
TLI	Tucker-Lewis index
CFI	Comparative fit index

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12903-024-05292-5>.

Additional file 1.

Additional file 2.

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Not applicable.

Authors' contributions

Jianping Zhao carried out the studies, participated in collecting data, and drafted the manuscript. Ai Cao and Linjun Xie performed the statistical

analysis, and participated in collecting data. Lei Shao conceived the study, designed the studies, and revised the paper. All authors read and approved the final manuscript.

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Data availability

All data generated or analysed during this study are included in this published article.

Declarations

Ethics approval and consent to participate

The study was approved by the Institutional Review Board of the Fourth Affiliated Hospital of Soochow University (Approval No: 231007). All participants were informed about the study protocol and provided written informed consent to participate in the study. I confirm that all methods were performed in accordance with the relevant guidelines. All procedures were performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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