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Original Article

Comparative Assessment of Dental Awareness Regarding Nutritional Adjuncts (Vitamins C and E) in Orthodontic Preventive Care: Insights from Different Academic Groups (A Cross-Sectional Survey)

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Abstract

Objective Oxidative stress, collagen synthesis, and inflammatory processes have a role in orthodontic movement of teeth. Vitamins C and E play supportive roles, but awareness among dental professionals might not be sufficient. This article aims to compare awareness of the role of vitamins C and E in orthodontic preventive care among Iraqi dental students and practitioners. This article aims to compare awareness of the role of vitamins C and E in orthodontic preventive care among Iraqi dental students and practitioners.

Materials and Methods A cross-sectional survey was conducted among a sample population of 490 respondents (234 undergraduates, 146 general and non-orthodontic practitioners, and 110 orthodontic practitioners). The survey questions covered the topics of awareness, behavior, perception, and attitudes. Data were analyzed using Chi-square and Kruskal–Wallis tests, with the level of statistical significance set at $p = 0.05$.

Results The level of awareness was greatest in orthodontic practitioners (58.2%), followed by undergraduates (42.3%) and general practitioners (28.8%). Use of nutritional supplements was also not very common, and intake of vitamin C–rich foods was more often than vitamin E–rich foods. The most preferred method for vitamin administration was systemic supplementation; however, the lack of strong evidence remained the main concern regarding the administration of vitamins C and E. The attitudes of all groups were positive toward the incorporation of nutritional adjuncts in patient care and education.

Conclusion Orthodontic practitioners were the most aware of vitamins C and E in prevention care in orthodontics; students, general, and non-orthodontic dentists

Keywords
- vitamin C
- vitamin E
- orthodontic adjunctive treatment
- dental awareness

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had significant gaps in their knowledge. Although there were positive attitudes toward the use of nutrition in education and patient care, there was limited use of supplements, and more robust evidence and improvement of the curriculum is necessary.

Introduction

Orthodontic tooth movement (OTM) is a mechanobiological process driven by the coordinated remodeling of dental and periodontal tissues in response to applied mechanical forces. These forces generate strain within the periodontal ligament (PDL), alveolar bone, and surrounding structures, initiating mechanotransductive cellular signaling that results in bone resorption on the pressure side and bone formation on the tension side.[1,2]

Surgical approaches, including corticotomy and piezocision, are based mainly on stimulating a regional acceleratory response in the alveolar bone.[3,4] In contrast, nonsurgical methods include physical, mechanical, and pharmacologic strategies, although the strength of evidence differs among these approaches.[5] Analgesic-related pharmacologic effects and laser-assisted flapless corticotomy have also been studied, reflecting the broad range of methods proposed to influence OTM.[6,7] More recently, advanced aligning archwires have been assessed in randomized clinical trials as mechanical adjuncts to improve treatment efficiency.[8] However, any attempt to accelerate tooth movement should be considered in relation to possible adverse effects, particularly external apical root resorption.[9] Therefore, interest has shifted toward adjuncts that may support orthodontic efficiency while maintaining biological safety.

Recently, attention has focused on the biochemical modulation of OTM, particularly through vitamins C and E. Vitamin C is an essential cofactor in collagen synthesis, osteoblast differentiation, matrix mineralization, and tissue repair, and experimental work suggests that it may influence the rate of tooth movement.[10,11] Its antioxidant properties also counteract the oxidative stress caused by orthodontic forces, thus improving periodontal healing and bone turnover.[12] Vitamin C deficiency has been associated with impaired periodontal tissue organization, whereas adequate ascorbic acid supports osteoblast and PDL cell differentiation and extracellular matrix formation.[10,13,14] Animal and a small prospective human studies have further suggested that vitamin C administration may facilitate OTM.[11,15,16]

Vitamin E, particularly α-tocopherol, has also attracted attention because of its antioxidant and anti-inflammatory effects. It can reduce oxidative stress in the orthodontic environment and modulate inflammatory responses related to bone remodeling.[17,18] In addition, in a rat model, vitamin E supplementation was reported to reduce stress associated with orthodontic force.[19] Nevertheless, its influence on bone metabolism remains controversial. Some studies have linked dietary or serum vitamin E with better bone mineral density, whereas others have reported increased osteoclast fusion or no clear effect on bone turnover markers.[20–22] In experimental orthodontic models, vitamin E-enriched diets have also been associated with accelerated tooth movement, suggesting that its biologic effects may depend on dose, context, and underlying bone dynamics.[23]

Dental education is not organized in the same way in all countries, and this difference should be considered when comparing knowledge between academic groups. In some countries, dentistry is taught through a graduate-entry DDS/DMD pathway, usually after completion of a bachelor's degree. In Iraq, dental education starts after secondary school and leads to a five-year Bachelor of Dental Surgery (BDS) degree. Orthodontic teaching is mainly introduced during the fourth and fifth academic years. After graduation, dentists who wish to specialize may continue through postgraduate training, commonly a 2- to 3-year master's program, followed by a 3- to 4-year PhD program for those pursuing an academic or specialist pathway. These differences in training may partly explain the variation in awareness of nutritional adjuncts between undergraduate students, general dentists, and orthodontic practitioners. A recent scoping review reported considerable variation in undergraduate orthodontic curricula, including learning outcomes, course content, competencies, and assessment methods.[24] Nutrition education in dental and oral health programs is also inconsistent, and this may reduce graduates' confidence in providing nutrition-related advice to patients.[25]

Despite promising preclinical findings, human evidence regarding the impact of vitamins C and E on orthodontic outcomes remains insufficient. A recent systematic review and meta-analysis on nutrition and orthodontic treatment reported that available studies could not conclusively establish a relationship between dietary intake and orthodontic treatment effectiveness.[26] Only a handful of studies have explored the effects of vitamins C and E on tooth movement, root resorption, and pain perception, with no randomized clinical trials providing definitive conclusions.[9,11,12,15,16,19,23] This paucity of evidence highlights the importance of awareness among dental students, who represent the future workforce responsible for integrating nutritional considerations into orthodontic preventive care. So, this study aims to comparatively assess undergraduate dental students' and dental practitioners' awareness across Iraqi dental colleges at different universities and health centers regarding the role of nutritional adjuncts, particularly vitamins C and E, in orthodontic preventive care, with the aim of identifying knowledge gaps that may inform curriculum development and evidence-based practice.

The null hypothesis presupposes that no significant difference exists among groups in terms of awareness,

perception, perceived quality of information, and attitude regarding vitamins C and E in orthodontic preventive care.

Materials and Methods

Study Design and Setting

This cross-sectional study was conducted to evaluate and compare awareness about the role of nutritional adjuncts (vitamins C and E) in the prevention of orthodontic problems. This manuscript was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guideline for cross-sectional studies.[27]

The population sample of the study comprised three groups: the first group consisted of fifth-stage undergraduate dental students of the governmental and private universities in Iraq (they were equally divided in terms of the type of university), the second group consisted of dental practitioners of different specialties, and the third group involved the orthodontic practitioners. This design allowed comparing students to practicing dentists and allowed to have a complete picture of the level of dental awareness.

This survey was a cross-sectional survey performed as a part of a randomized clinical trial. The ethics committee at the College of Dentistry, University of Baghdad, provided the ethical approval (reference no. 1014, dated January 21, 2025).

Sample Size Calculation

The 234 undergraduate dental students were randomly selected and evenly represented across the number of universities. Moreover, 256 dental practitioners with different specialties were enrolled. The minimum required sample size was calculated using the single-proportion formula for cross-sectional studies, assuming a 95% confidence level, 5% margin of error, and a conservative expected proportion of 50%,[28] that will provide adequate statistical power for comparative analysis between students and dentists.

Participants and Eligibility

Participation in this study was voluntary and anonymous, ensuring confidentiality and adherence to ethical standards.

Inclusion Criteria

- Undergraduate dental students, in their fifth stage, in the governmental and private Universities of Iraq.
- Postgraduate dental students and dental practitioners across different specialties, as long as they were officially registered with the Iraqi Dental Association.

Exclusion Criteria

- First- to fourth-stage undergraduate dental students.
- Some of the answers have not been given or are invalid.

Questionnaire Development

The questionnaire was prepared by the research team and reviewed by an expert panel that included two orthodontists, one with an MSc degree and one with a PhD, and a clinical pharmacist with a PhD. The initial items were drafted from published literature on OTM, periodontal inflammation, oxidative stress, and the biological roles of vitamins C and E.[1,2,10–23,29,30] Items related to preventive care and patient counselling were guided by orthodontic practice and patient-education literature.[31–33] The panel then revised the draft to improve relevance, clarity, and suitability for the three participant groups.

The areas addressed included the following:

- *Demographic variables*: Among them are age category, gender, academic level, years of clinical practice, place of practice, and reliable sources of health information.
- *General awareness*: General knowledge on the use of vitamins C and E in health in general and orthodontics; the perceived impact on the speed of the treatment process and the comfort of the process; knowledge of their basic biological functions, e.g., immunity, formation of collagen, antioxidant activity.
- *Personal experience and behavior*: Patterns of supplement intakes during orthodontic treatment; extent of clinician–patient dialogues on nutritional adjuncts with orthodontic treatment; frequency of dietary intakes of foods rich in vitamin C/E during the pre-treatment, treatment, and post-treatment periods.
- *Perception*: Confirmed training requirements of the academic groups; information quality evaluation available; interest in evidence-based seminars; preferences regarding method of vitamins administration (systemic or local); issues related to level of evidence, side effects, patient compliance, and cost.
- *Attitude*: Agreement of incorporating education regarding medications, vitamins, food, and other herbal adjuncts into the dental treatment for orthodontics; perceived importance of lifestyle and dietary habits on treatment outcome; assessment of adequacy of current educational approaches; support for curricular integration of nutritional adjuncts.

Pilot Testing, Validity

The preliminary questions were pilot tested on 20 individuals to check on the clarity, relevance, and comprehensibility. The analysis of feedback at this stage was managed in a systematic manner and resulted in modifications in terms of wording, structure of items, and responses, while maintaining coverage in the four predefined domains.

Expert panel review was then applied to determine content validity, and measured the relevance, clarity, simplicity, and lack of ambiguity of each item. This process involved iteration so that the end product was not only scientifically rigorous but also practical for the population it was intended to serve.

Data Collection and Variables

The structured electronic survey form was used to gather the data that were collected within the period October 30, 2025, and December 25, 2025. The survey link was shared across various social media platforms such as Facebook, WhatsApp, Telegram, and Instagram, to reach the maximum number of

participants in different participant groups. Informed consent was sought on the first page, and all answers were anonymized to ensure confidentiality and compliance with ethical standards.

Statistical Analysis

All collected data were coded and documented in the Statistical Package for the Social Sciences (SPSS, version 26.0 for Windows; IBM Corp., Armonk, New York, United States) for data analysis. Since the variables in this study were either nominal or ordinal in nature, no normality testing was performed. Descriptive statistics were used to summarize demographic characteristics and response frequencies.

For categorical (nominal) variables, associations between groups were examined using the Chi-square test of independence. This test was selected because it is appropriate for evaluating differences in distribution across categorical responses without assuming parametric conditions.

For ordinal variables, specifically items assessing frequency of vitamin C and E consumption during and beyond orthodontic treatment, perceived quality of information, and attitudinal statements rated on ordered scales, the Kruskal–Wallis test was applied. This non-parametric test was chosen to compare distributions across multiple groups while accounting for the ranked nature of the data. A two-tailed significance level of $p < 0.05$ was considered statistically significant for all analyses.

Results

Demographic Characteristics

A total of 490 participants were included: 234 undergraduate students (47.8%), 146 general/non-orthodontic practitioners (29.8%), and 110 orthodontic practitioners (22.4%) (►**Table 1**). Age distribution showed that most undergraduates were between 18 and 24 years (209; 89.3%), while the majority of general/non-orthodontic and orthodontic practitioners were between 31 and 40 years (79; 54.1% and 49; 44.5%, respectively) (►**Table 1**). Females represented 55.1% of the undergraduates and 56.4% of the orthodontic practitioners, whereas males predominated among general practitioners (59.6%) (►**Table 1**). Most practitioners reported more than 5 years of clinical experience (94; 64.4% general/non-orthodontic and 70; 63.6% orthodontic) (►**Table 1**). Sources of information varied significantly: undergraduates relied mainly on dentists/orthodontists (110; 47.0%) and university lectures (46; 19.7%), while general/non-orthodontic practitioners relied on scientific papers (81; 55.5%). Similarly,

Table 1 Distribution of demographic characteristics among groups

Character		Participants' groups					
		Undergraduate student (US)		General and non-orthodontic practitioners (GP and NOP)		Orthodontic practitioners (OP)	
		Frequency	%	Frequency	%	Frequency	%
Educational and professional background	US\Government university	117	50.0				
	US\Private university	117	50.0				
	GP and NOP			146	100		
	OP					110	100
Age	18–24 y	209	89.3				
	25–34 y	25	10.7				
	20–30 y			45	30.8	19	17.3
	31–40 y			79	54.1	49	44.5
	41–50 y			19	13.0	35	31.8
	51 y and above			3	2.1	7	6.4
Gender	Male	105	44.9	87	59.6	48	43.6
	Female	129	55.1	59	40.4	62	56.4
Place of practice	Academic institution and hospital			48	32.9	24	21.8
	Private clinic			28	19.2	20	18.2
	Academic institution, hospital, and private clinic			26	17.8	48	43.6
Clinical experience	1–5 y			42	28.8	35	31.8
	Less than 5 y			9	6.2	5	4.5
	More than 5 y			94	64.4	70	63.6

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Table 1 (*Continued*)

Character		Participants' groups					
		Undergraduate student (US)		General and non-orthodontic practitioners (GP and NOP)		Orthodontic practitioners (OP)	
		Frequency	%	Frequency	%	Frequency	%
Orthodontic treatment status	No	173	73.9	101	69.2	71	64.5
	Yes, healthy participants	54	23.1	43	29.5	37	33.6
	Yes, compromised participants	7	3.0	2	14	2	1.8
Source of information	Dentist/Orthodontist	110	47.0	36	24.7	24	21.8
	Friends/Family	5	2.1	1	0.7		
	Internet	20	8.5	10	6.8	3	2.7
	Scientific papers	45	19.2	81	55.5	77	70
	Social media	8	3.4	1	0.7	1	0.9
	University lectures	46	19.7	17	11.6	5	4.5

Abbreviations: GP and NOP, general and non-orthodontic practitioners; OP, orthodontic practitioners; US, undergraduate student.

orthodontic practitioners are mostly trusted on scientific papers (77; 70.0%) (►**Table 1**). Orthodontic treatment history revealed that most participants had never undergone treatment (173; 73.9% undergraduates, 101; 69.2% general/non-orthodontic, 71; 64.5% orthodontic), while others had undergone orthodontic treatment and indicated that their health status was good during that time (54 undergraduates, 23.1%; 43 general/non-orthodontic practitioners, 29.5%; and 37 orthodontic practitioners, 33.6%) (►**Table 1**).

Awareness and Knowledge

Awareness of the roles of vitamins C and E in orthodontics differed significantly across groups ($p < 0.001$) (►**Fig. 1**).

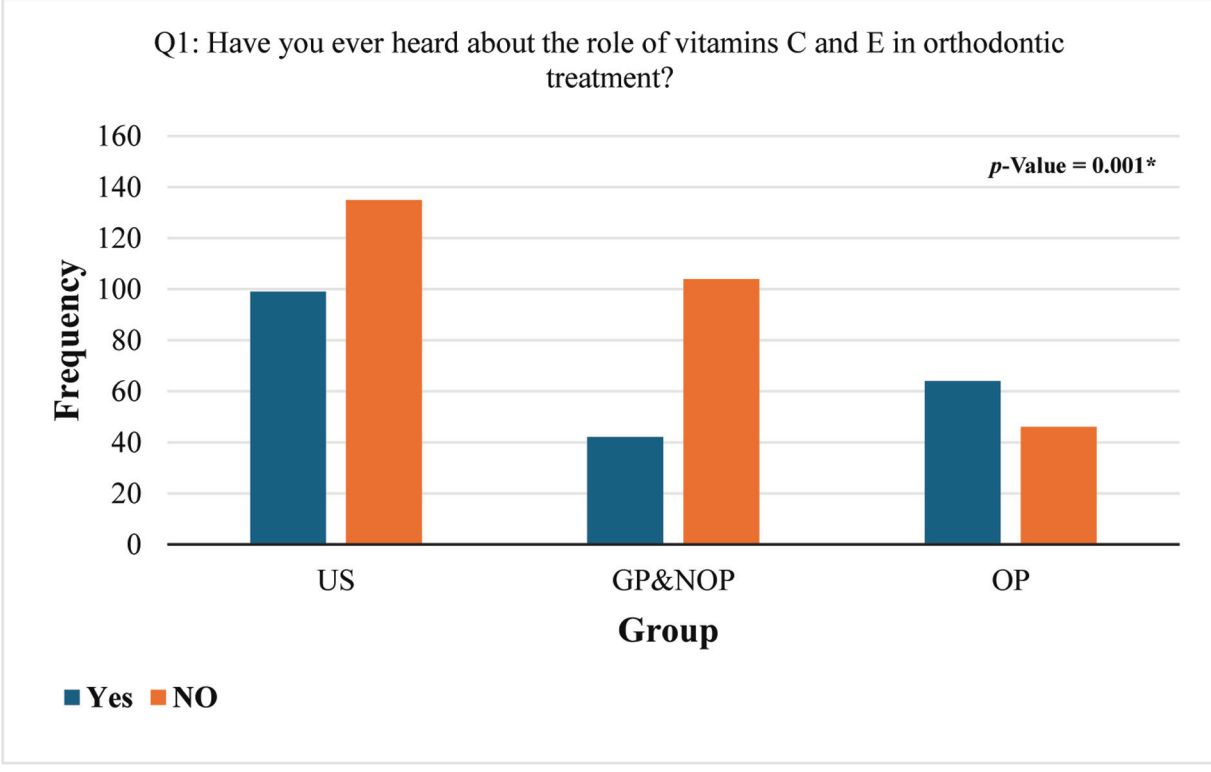


Fig. 1 Distribution of responses for question 1. *Significant. G, group; Q, question; US, undergraduate student, GP&NOP, general and non-orthodontic practitioners; OP, orthodontic practitioners.

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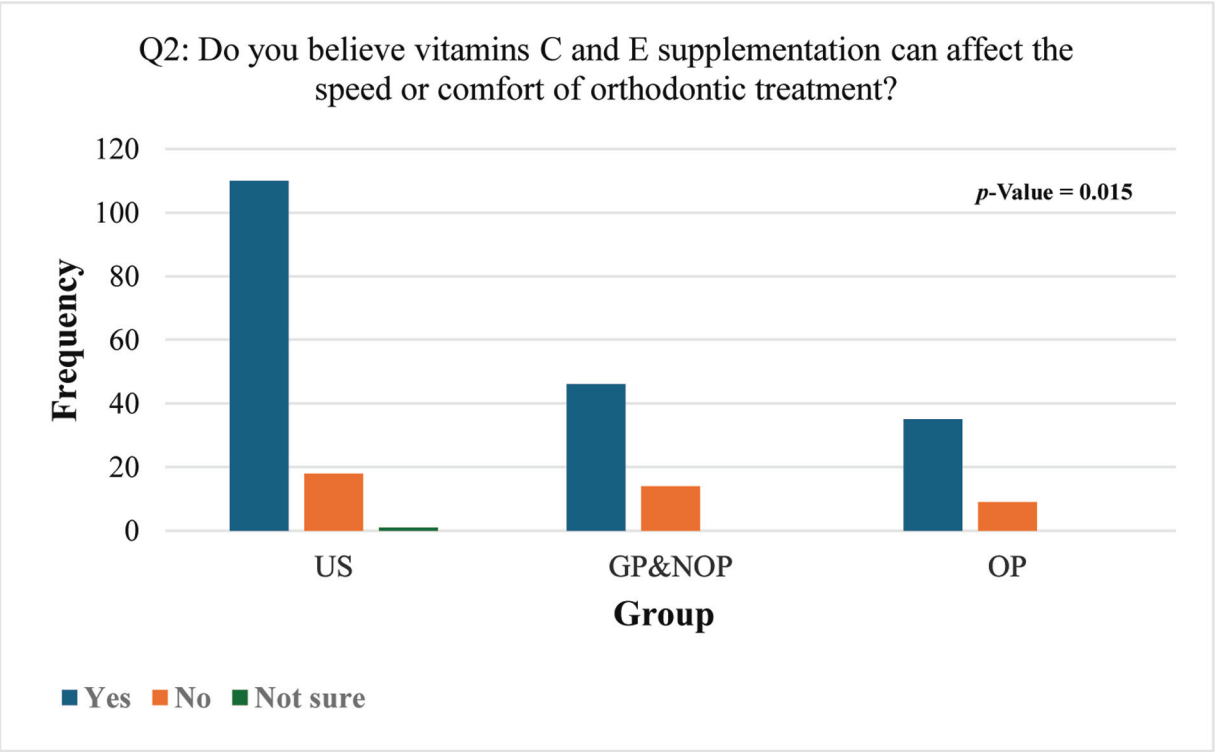


Fig. 2 Distribution of responses for question 2. G, Group; Q, question; US, undergraduate student; GP&NOP, general and non-orthodontic practitioners; OP, orthodontic practitioners.

Only 42.3% of undergraduates reported awareness compared with 58.2% of orthodontic practitioners, while general/non-orthodontic practitioners showed the lowest awareness (28.8%). Beliefs about the effect of supplementation on treatment speed or comfort differed significantly ($p = 0.015$) (►**Fig. 2**), with 47.0% of undergraduates and 31.8% of orthodontic specialists responding "Yes," while this response was only reported by 31.5% of general/non-orthodontic practitioners. Knowledge of vitamin C role in immunity was recognized by 73.3% of undergraduates, 77.3% of general/non-orthodontic practitioners, and 68.6% of orthodontic practitioners ($p = 0.005$) (►**Fig. 3**). Another rank was the antioxidant role ($p = 0.035$) where the orthodontic practitioners were the most aware (63.6%) followed by the undergraduates (48.7%) and the general/non-orthodontic practitioners (53.4%). In the case of vitamin E, the protection of cell membranes showed a borderline significant difference among groups ($p = 0.046$) (►**Fig. 4**) but was significantly higher among orthodontic practitioners (56.4%) than undergraduates (42.1%) and general/non-orthodontic practitioners (46.6%).

Personal Experience and Behavior

Among all groups, supplement use during orthodontic treatment was very rare, as 21.3% of undergraduate students, 17.8% of general and non-orthodontic practitioners, and 5.1% of orthodontic practitioners reported using it (►**Table 2**). Discussions with orthodontists were uncommon, which was reported by 11.5% of undergraduates, 6.7% general/non-orthodontic practitioners, and 2.6% of orthodontic practitioners (►**Table 2**).

Dietary behavior for participants who had orthodontic treatment showed a clear preference for vitamin C-rich foods, which were consumed "often" or "always" by a substantial proportion of participants across all groups. In contrast, the regular intake of vitamin E-rich foods was generally lower and less frequent. Before and after orthodontic treatment, vitamin C consumption remained consistently higher, whereas vitamin E intake stayed relatively limited across all professional groups (►**Table 3**).

Perception toward Vitamins C and E

Regarding the method of vitamin administration, systemic supplementation was the most desirable method of vitamin administration, followed by local gingival injection, and there was general low opposition to the suggestion of vitamins in orthodontic preventive measures. The primary concern regarding supplementation was the lack of strong scientific evidence, which is reported most frequently by orthodontic practitioners (46.4%), followed by general and non-orthodontic practitioners (28.8%), and undergraduate students (19.2%). Secondary concerns included patient compliance and potential side effects, whereas cost-related issues were the least frequently mentioned (►**Table 4**).

Attitude toward Vitamin C and E

There was a positive attitude toward the influence of vitamins, diet, and herbal products in the treatment of

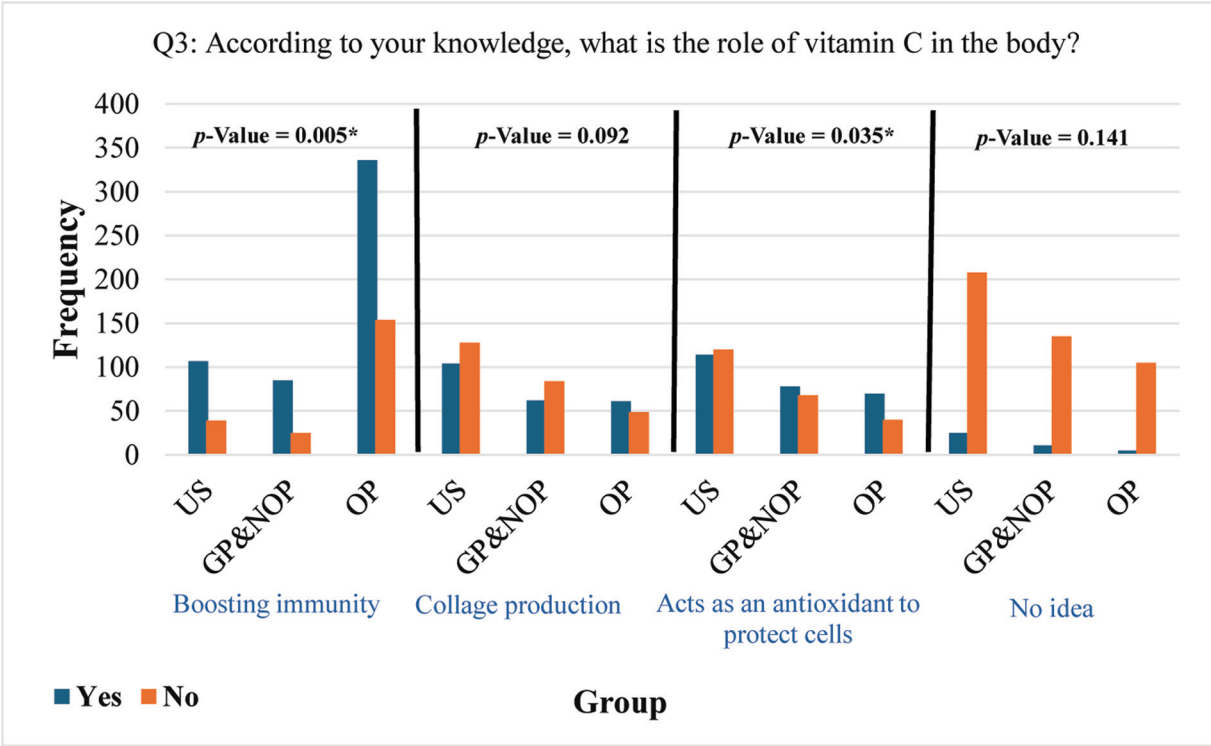


Fig. 3 Distribution of responses for question 3. *Significant. G, Group; Q, question; US, undergraduate student; GP&NOP, general and non-orthodontic practitioners; OP, orthodontic practitioners.

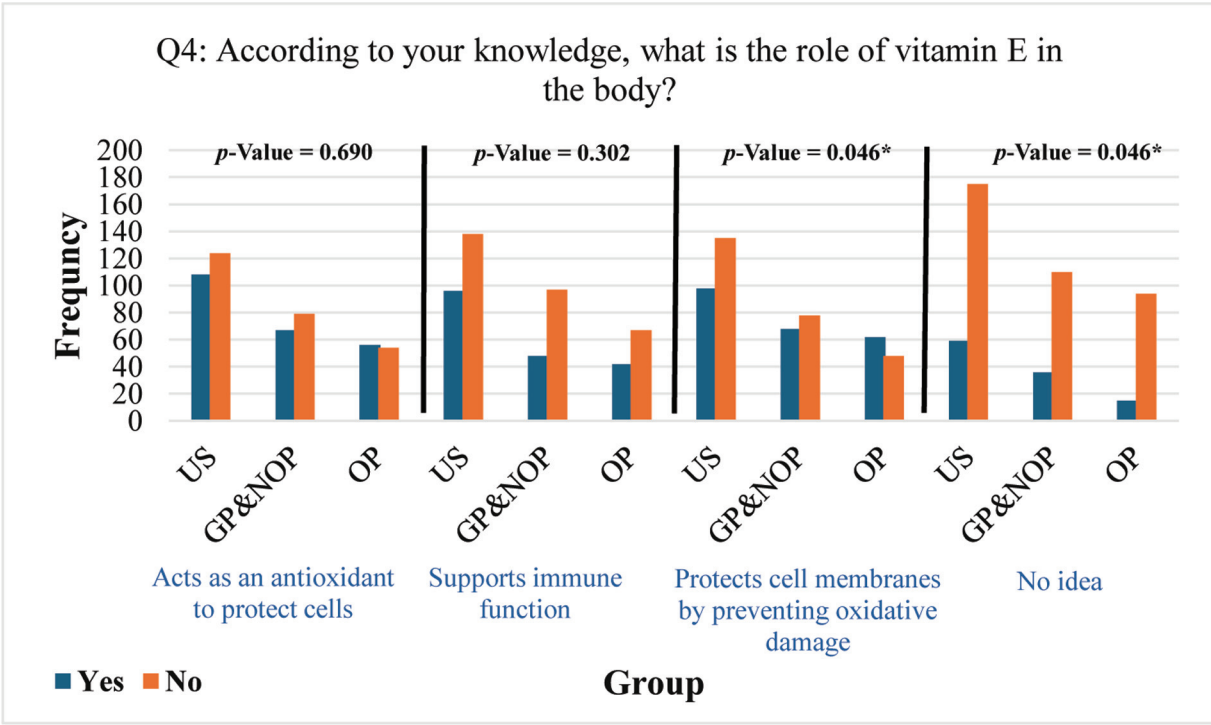


Fig. 4 Distribution of responses for question 4. *Significant. G, Group; Q, question; US, undergraduate student; GP&NOP, general and non-orthodontic practitioners; OP, orthodontic practitioners.

orthodontics in all groups of professionals. The participants also emphasized the importance of patient education on such aspects and reported that they are not adequately covered in current undergraduate curricula (►**Table 5**).

Discussion

This research was conducted to assess awareness and perception regarding the roles of vitamins C and E in

Table 2 Chi-square analysis of personal experience and behavior of vitamins C and E in orthodontic treatment among undergraduate students, general and non-orthodontic practitioners, and orthodontic practitioners' groups

Group	Q1: If you are currently in treatment or had it in the past, did you take any vitamin C and E as supplements during that time (for treatment purpose)?						
	Yes			No			*p*-Value
	Count	% within Q1	% within G	Count	% within Q1	% within G	
US	13	56.5%	21.3%	48	39.3%	78.7%	0.089
GP and NOP	8	34.8%	17.8%	37	30.3%	82.2%	
OP	2	8.7%	5.1%	37	30.3%	94.9%	
Group	Q2: Have you ever discussed vitamins C and E intake with your orthodontist?						
	Yes			No			*p*-Value
	Count	% within Q1	% within G	Count	% within Q1	% within G	
US	7	63.6%	11.5%	54	40.3%	88.5%	0.293
GP and NOP	3	27.3%	6.7%	42	31.3%	93.3%	
OP	1	9.1%	2.6%	38	28.4%	97.4%	

Abbreviations: G, group; GP and NOP, general and non-orthodontic practitioners; OP, orthodontic practitioners; Q, question; US, undergraduate student.

Table 3 Kruskal–Wallis test comparison of personal experience and behavior of vitamins C and E in orthodontic treatment among undergraduate students, general and non-orthodontic practitioners, and orthodontic practitioners' groups

Group	Q3: During your orthodontic treatment, how often did you consume foods rich in vitamin C (e.g., citrus fruits, bell peppers)?		
	No	Mean rank	*p*-Value
US	61	115.00 B	>0.001[a]
GP and NOP	45	43.30 A	
OP	39	41.58 A	
Group	Q4: During your orthodontic treatment, how often did you consume foods rich in vitamin E (e.g., nuts, seeds, spinach)?		
	No	Mean Rank	P value
US	61	69.63	0.649
GP and NOP	45	76.77	
OP	39	73.92	
Group	Q5: Pre- or post-orthodontic treatment, how often do you consume foods rich in vitamin C?		
	No	Mean Rank	*p*-Value
US	61	61.82 AC	0.012[a]
GP and NOP	45	83.96 BC	
OP	39	77.85 C	
Group	Q6: Pre- or post-orthodontic treatment, how often do you consume foods rich in vitamin E?		
	No	Mean rank	*p*-Value
US	61	70.30	0.689
GP and NOP	45	72.93	
OP	39	77.31	

Abbreviations: GP and NOP, general and non-orthodontic practitioners; OP, orthodontic practitioners; US, undergraduate student.
[a]Significant.
Notes: Dissimilar letters indicate a statistically significant difference at $p < 0.05$.
For Q3, significant differences were observed between US and GP and NOP ($p > 0.001$) and between US and OP ($p > 0.001$).
For Q6, a significant difference was found between US and GP and NOP ($p = 0.014$).

Table 4 Chi-square analysis of perception of vitamins C and E in orthodontic treatment among undergraduate students, general and non-orthodontic practitioners, and orthodontic practitioners' groups

Group	Q1: In your opinion, which academic group should receive more training on vitamins in orthodontics?									
	Undergraduate students			Postgraduate students in orthodontics			Both equally			*p*-Value
	Count	% within Q1	% within G	Count	% within Q1	% within G	Count	% within Q1	% within G	
US	46	67.6%	19.7%	56	35.7%	23.9%	132	49.8%	56.4%	>0.001
GP and NOP	17	25.0%	11.6%	52	33.1%	35.6%	77	29.1%	52.7%	
OP	5	4.5%	4.5%	49	31.2%	44.5%	56	21.1%	50.9%	
Total	68	100.0%	13.9%	157	100.0%	32.0%	265	100.0%	54.1%	
Group	Q2: If a seminar or conference were held to present scientific evidence on the role of vitamins in orthodontic care, would you be interested in attending?									
	Yes, definitely			Maybe, depending on the topic			No, not interested			*p*-Value
	Count	% within Q1	% within G	Count	% within Q1	% within G	Count	% within Q1	% within G	
US	86	39.8%	36.8%	129	53.3%	55.1%	19	59.4%	8.1%	0.014
GP and NOP	70	32.4%	47.9%	66	27.3%	45.2%	10	31.3%	6.8%	
OP	60	27.8%	54.5%	47	19.4%	42.7%	3	9.4%	2.7%	
Total	216	100.0%	44.1%	242	100.0%	49.4%	32	100.0%	6.5%	
Group	Q3: If scientific evidence confirms that specific vitamins improve orthodontic outcomes, which delivery method would you prefer to recommend?									
	Systemic supplementation			Local delivery to gingival tissue (injection or gel)			I would not recommend vitamin supplementation			*p*-Value
	Count	% within Q1	% within G	Count	% within Q1	% within G	Count	% within Q1	% within G	
US	168	48.1%	71.8%	53	44.5%	22.6%	13	59.1%	5.6%	0.565
GP and NOP	106	30.4%	72.6%	34	28.6%	23.3%	6	27.3%	4.1%	
OP	75	21.5%	68.2%	32	26.9%	29.1%	3	13.6%	2.7%	
Total	349	100.0%	71.2%	119	100.0%	24.3%	22	100.0%	4.5%	
Group	Q4: What is your main concern regarding recommending vitamin supplements during orthodontic treatment?												
	Lack of strong evidence			Risk of side effects or interactions			Patient compliance			Cost or accessibility			*p*-Value
	Count	% within Q1	% within G	Count	% within Q1	% within G	Count	% within Q1	% within G	Count	% within Q1	% within G	
US	45	32.6%	19.2%	65	59.6%	27.8%	41	40.6%	17.5%	23	62.2%	9.8%	0.014[a]
GP and NOP	42	30.4%	28.8%	26	23.9%	17.8%	33	32.7%	22.6%	13	35.1%	8.9%	
OP	51	37.0%	46.4%	18	16.5%	16.4%	27	26.7%	24.5%	1	2.7%	0.9%	
Total	138	100%	28.2%	109	100%	22.2%	101	100%	20.6%	37	100%	7.6%	

Abbreviations: GP and NOP, general and non-orthodontic practitioners; OP, orthodontic practitioners; US, undergraduate student.
[a]Significant.

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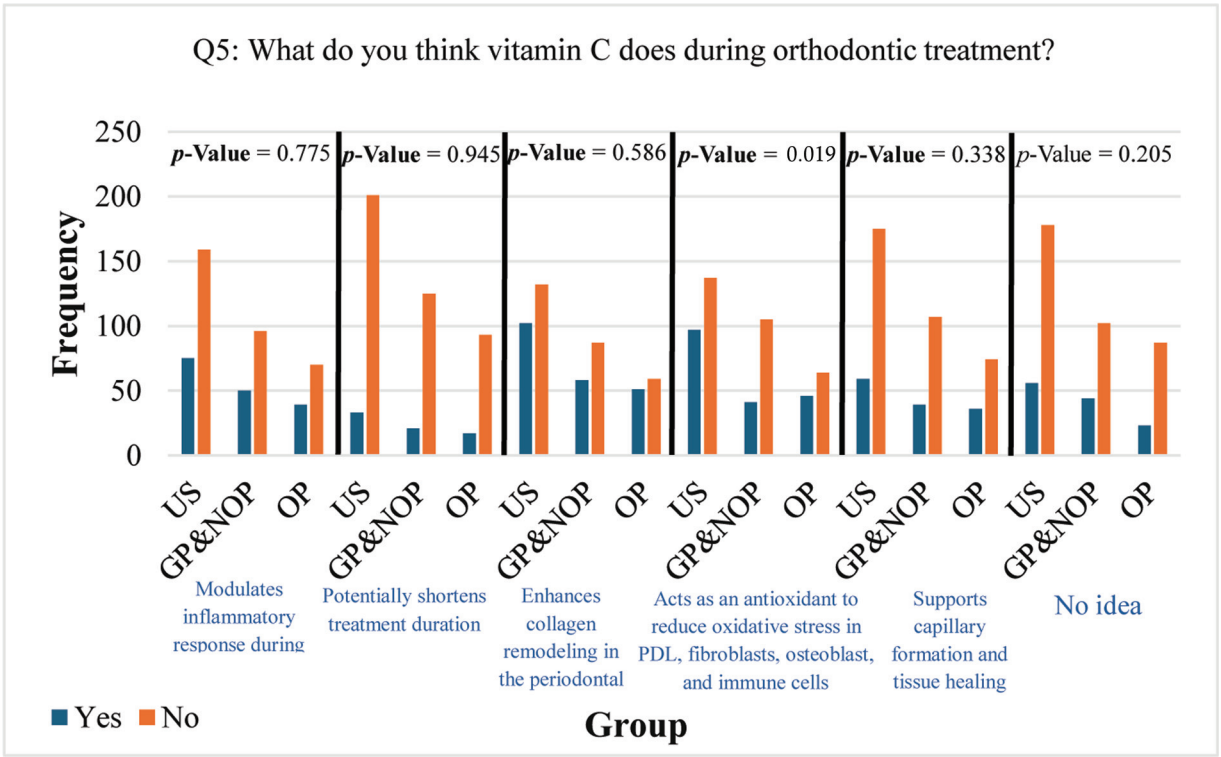


Fig. 5 Distribution of responses for question 5. *Significant. G, Group; Q, question; US, undergraduate student; GP&NOP, general and non-orthodontic practitioners; OP, orthodontic practitioners.

orthodontic prevention care across different academic disciplines; analyses were then based on the variations in domains.

To eliminate biological confounding and maintain internal validity, the current study aimed at investigating awareness and perception, rather than direct supplementation outcomes, thereby ensuring that the findings reflect knowledge gaps rather than treatment variability. This multilayered structure made sure that the survey captured not only awareness but also behavioral practices, perceptions, and attitudes, thereby providing a comprehensive view of nutritional adjuncts involved in orthodontic preventive care.

Significant differences were observed among groups in awareness, perception, and perceived quality of information regarding vitamins C and E in orthodontic preventive care ($p < 0.05$), and the null hypothesis was rejected accordingly. Conversely, there was no significant difference between the attitudes toward patient education and curricular integration ($p > 0.05$), thus, there was insufficient evidence to reject the null hypothesis in this domain.

Regarding the general awareness domain (►**Figs. 1**–**6**), orthodontic practitioners were found to be more aware of the role of vitamins C and E in orthodontic treatment (58.2%), as opposed to the undergraduates (42.3%), and general/non-orthodontic practitioners (28.8%). Orthodontic practitioners showed the highest awareness of the role of vitamins C and E in orthodontic treatment compared with undergraduates and general/non-orthodontic practitioners. This pattern may be explained by their greater exposure to the biological basis of OTM, including inflammatory responses and chemical mediators involved in periodontal remodeling.[29] However, awareness remained relatively modest even among specialists, suggesting that biologic concepts are not yet fully translated into routine clinical decision-making. This interpretation is supported by the limited clinical evidence on nutrition-related interventions in orthodontic treatment[26] and by the broader translational gap between regenerative orthodontic concepts and established clinical application.[34]

Nearly half of the undergraduates (47.0%) and one-third of the orthodontic practitioners (31.8%) believed that supplementation could influence treatment speed or comfort, whereas most general practitioners remained uncertain (58.9%). This divergence reflects optimism among students versus clinical caution among practitioners. Preclinical studies suggest that vitamin C may influence OTM biology through osteoclast activity, collagen remodeling, and bone formation; however, effects on the actual rate of tooth movement are inconsistent and should be interpreted cautiously.[11,12,15] In theory, these hypotheses are correct, although the human evidence is limited. Nevertheless, accelerated tooth movement should be interpreted cautiously because orthodontic treatment may be associated with external apical root resorption.[9] Taken together, the present data justify a cautious interpretation: students' enthusiasm reflects academic exposure and optimism, while practitioners' hesitancy is rooted in clinical concerns regarding potential adverse outcomes.

The level of awareness regarding the role of vitamin C in immunity was similar among groups (73.3% undergraduate

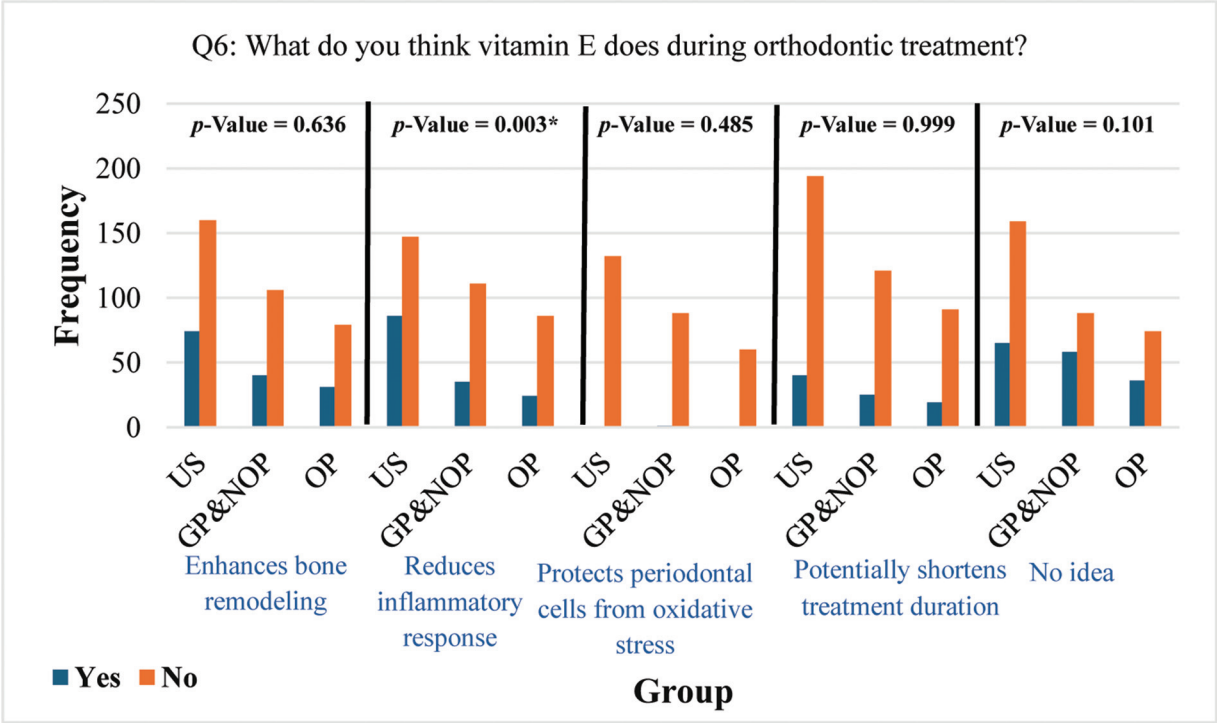


Fig. 6 Distribution of responses for question 6. *Significant. G, Group; Q, question; US, undergraduate student; GP&NOP, general and non-orthodontic practitioners; OP, orthodontic practitioners.

students, 77.3% general/non-orthodontic practitioners, 68.6% orthodontic practitioners). This finding is consistent with the established biological role of vitamin C in collagen synthesis, PDL cell differentiation, and tissue repair.[10,13,14,35] This finding is biologically plausible because OTM involves inflammatory responses in the PDL and dental pulp, as described by Yamaguchi and Garlet.[30] In addition, vitamins C and E have been investigated as antioxidant modulators of oxidative stress during OTM.[12,17,18] This perspective underscores the relevance of antioxidants in mitigating oxidative periodontal tissue damage.

The difference was significant ($p = 0.046$) with respect to vitamin E in the recognition of the importance of vitamin E in maintaining cell membranes. Orthodontic practitioners demonstrated the greatest recognition (56.4%); followed by general/non-orthodontic practitioners (46.6%), and undergraduate students were the least recognized (42.1%). This trend is consistent with the established biological role of vitamin E, particularly α-tocopherol, as an antioxidant that helps limit lipid peroxidation and oxidative stress, thereby contributing to cellular membrane protection.[17,18] Nevertheless, studies reporting associations between vitamin E status and bone mineral density[20] should be interpreted cautiously because other evidence suggests potentially divergent effects of vitamin E on bone remodeling, including osteoclast fusion and bone turnover markers.[21,22]

Regarding personal experience and behavior domain (►**Tables 2** and **3**), the use of supplements during orthodontic treatment was not very common in all groups (21.3% undergraduate students, 17.8% general/non-orthodontic practitioners, 5.1% orthodontic practitioners). Dietary behavior showed a consistent preference for vitamin C-rich foods, whereas vitamin E intake was lower. This may be related to greater familiarity with vitamin C because of its established biological role in collagen synthesis, PDL cell differentiation, and tissue repair.[10,13,14] Moreover, the importance of periodontal supporting tissues in orthodontic and regenerative contexts has been emphasized in the literature.[36] The lower intake of vitamin E may reflect lower awareness of its antioxidant role and the inconsistent evidence regarding its effects on bone metabolism and OTM.[17,18,20–23]

In the aspect of perception (►**Tables 4** and **6**), the statistical process showed that the majority of the respondents believed that undergraduate and postgraduate students ought to be equally provided with more training on the use of vitamins in orthodontics (54.1%). This equitable opinion suggests the awareness of the significance of nutritional supplements throughout the academic levels. More intriguingly, dental orthodontists were more apt to underline postgraduate education (44.5%) as a symbol of their practice experience and the realization of new biological processes. This perception is better explained by the documented variability in undergraduate orthodontic curricula and by the inconsistent inclusion of nutrition education within dental and oral health programmes.[24,25] Regenerative and biologic adjunctive concepts have also been discussed in the context of adult orthodontics,[34] but their clinical application requires stronger evidence and structured training. On the interest in attending seminars, almost 50%

Table 5 Chi-square analysis of attitude of vitamins C and E in orthodontic treatment among undergraduate students, general and non-orthodontic practitioners, and orthodontic practitioners' groups

Group	Q1: Orthodontists should educate patients about the effects of medications, vitamins, food, and herbal consumption during orthodontic treatment		
	No.	Mean rank	*p*-Value
US	234	246.13	0.727
GP and NOP	146	250.62	
OP	110	237.37	
Group	Q2: Poor dietary habits, and inappropriate use of medications and herbal products can negatively influence the outcome of orthodontic treatment		
	No.	Mean rank	*p*-Value
US	234	244.00	0.160
GP and NOP	146	260.44	
OP	110	228.87	
Group	Q3: Understanding the biological role of food, medications, vitamins, and herbal consumption could improve the treatment experience or outcomes		
	No.	Mean rank	*p*-Value
US	234	254.28	0.242
GP and NOP	146	243.52	
OP	110	229.45	
Group	Q4: Undergraduate dental students already receive adequate education about the biological impact of medications, vitamins, and herbal supplements on dental tissues		
	No.	Mean rank	*p*-Value
US	234	248.82	0.576
GP and NOP	146	235.70	
OP	110	251.45	
Group	Q5: Enhancing dental students' knowledge regarding the biological effects of medications, vitamins, food, and herbal consumption on orthodontic treatment is necessary, and should be addressed through incorporating dedicated lectures in undergraduate and/or postgraduate curricula		
	No.	Mean rank	*p*-Value
US	234	242.92	0.733
GP and NOP	146	243.13	
OP	110	254.14	

Abbreviations: GP and NOP, general and non-orthodontic practitioners; OP, orthodontic practitioners; US, undergraduate student.

(conditional, maybe, depending on the topic) of the respondents showed interest, and 44.1% showed definite interest. The greatest interest (54.5%), however, was demonstrated by orthodontic practitioners, and this can be attributed to the fact that the scientific papers are the primary source of information they use (►**Table 1**). The highest enthusiasm was shown by orthodontic practitioners (54.5%), which is in line with the fact that they utilize scientific papers as the main sources of information (►**Table 1**). This interest in seminars is consistent with the documented variability in undergraduate orthodontic curricula and the inconsistent integration of nutrition education within dental and oral health programmes.[24,25] The interest in seminars may reflect the need to translate complex biological concepts, such as mechanotransduction and oxidative stress, into clinically usable educational content.[2,12,17,18] Systemic vitamins administration method (71.2%) was also preferred over the local gingival administration method (24.3%). There is minimal opposition to vitamin administration (4.5%), which indicates general openness if the evidence is strong. Preference for systemic administration may reflect its familiarity, ease of use, and noninvasive nature; however, this preference should not be interpreted as evidence of clinical superiority. Therefore, any recommendation for systemic supplementation should remain evidence-based and cautious.[9,26] The most prevalent concerns included the absence of strong evidence (28.2%), side effects (22.2%), and compliance (20.6%), and cost was mentioned the least (7.6%). The uncertainty regarding vitamin E is biologically plausible because available studies have reported mixed effects on bone

Table 6 Kruskal–Wallis test comparison of perception of vitamins C and E in orthodontic treatment among undergraduate students, general and non-orthodontic practitioners, and orthodontic practitioners' groups

Group	Q5: How would you rate the quality of available information (online or offline) about vitamins and orthodontic care?		
	No.	Mean rank	*p*-Value
US	234	216.97 B	0.001[a]
GP and NOP	146	271.54 A	
OP	110	271.62 A	

Abbreviations: GP and NOP, general and non-orthodontic practitioners; OP, orthodontic practitioners; US, undergraduate student.
[a]Significant.
Notes: Dissimilar letters indicate a statistically significant difference at $p < 0.05$.
Significant differences were found between US and GP and NOP ($p = 0.001$) and between US and OP ($p = 0.002$).

metabolism and OTM, including associations with bone mineral density, osteoclast fusion, bone turnover markers, and experimental OTM.[20–23] This observation is more directly supported by evidence showing variability in orthodontic curricula and inconsistent nutrition education within dental and oral health programmes.[24,25]

Regarding the attitude domain (►**Table 5**), statistical analysis showed positive orientations across all groups. Most participants agreed that orthodontists should educate patients about nutrition and adjuncts, which is consistent with the educational emphasis in contemporary orthodontic practice.[33] Participants also recognized that poor dietary habits, inadequate oral hygiene behavior, and periodontal condition could negatively affect orthodontic preventive outcomes. This view is supported by evidence highlighting the importance of periodontal phenotype in dental treatment outcomes,[37] and by recent expert consensus emphasizing proactive prevention, patient health education, risk assessment, early detection, and follow-up for enamel demineralization during orthodontic treatment.[38] Respondents also endorsed the importance of understanding the biological roles of vitamins, which is consistent with evidence on periodontal supporting tissue development and regeneration[36] and with the role of matrix metalloproteinases in periodontal tissue turnover and inflammatory breakdown.[39,40] However, participants expressed mixed views regarding the adequacy of current curricula, supporting the need for stronger evidence-based integration of nutrition-related and biologic adjunct concepts into undergraduate and postgraduate dental education.[24,25] Finally, the strong consensus on the need for dedicated lectures further highlights the importance of structured, evidence-based education on nutritional adjuncts in orthodontic preventive care.[24–26]

The large and heterogeneous sample, participation of various professional groups, and the use of a validated multidomain survey were the strengths of this study, as it had a complete picture of awareness, perception, and attitudes toward nutritional adjuncts in orthodontic preventive care. Besides, there are not many studies that focus on this issue systematically. Nevertheless, the cross-sectional nature and the use of self-reported data restrict causality and can produce bias, and results cannot be completely applied to other settings, nor is the clinical efficacy of supplementation studied.

Conclusion

This comparative assessment showed that awareness and perception of vitamins C and E in orthodontic preventive care varied across academic groups. Orthodontic practitioners demonstrated higher recognition of antioxidant roles, yet notable knowledge gaps persisted among undergraduates and general dentists. Students tended to view supplementation optimistically, whereas clinicians were more cautious, reflecting limited clinical evidence. Despite positive attitudes toward integrating nutritional adjuncts into education and patient counseling, actual use of supplements remained uncommon, highlighting the gap between knowledge and practice. These findings underscore the need for evidence-based curricular refinement, targeted postgraduate training, and robust clinical trials to clarify the biological and therapeutic relevance of vitamins C and E in orthodontics.

Conflict of Interest
None declared.

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