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Public awareness, preferences, and myths regarding tooth whitening: a cross-sectional survey

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Abstract

Background To evaluate public awareness, information sources, treatment preferences, safety perceptions, and common myths regarding tooth whitening and to investigate whether these perceptions differ according to gender and educational level.

Methods A cross-sectional survey was conducted among 532 adults recruited via convenience sampling in Türkiye. A 19-item questionnaire, developed through a literature review, expert evaluation, and pilot testing, assessed participants' demographic characteristics, information sources, treatment preferences, safety perceptions, and beliefs regarding professional and alternative whitening methods. Associations between responses and gender or educational level were analyzed using Pearson chi-square and Rao–Scott chi-square tests ($\alpha = 0.05$). Associations among the questionnaire items were additionally explored using Pearson chi-square tests with Cramer's V and Bonferroni adjustment.

Results Dentists were the primary source of tooth-whitening information (58.08%), followed by social media (36.09%). Gender significantly influenced both beliefs and behaviors related to tooth whitening. Female participants were more likely to believe that white teeth improve self-confidence, perceive whitening as harmful, believe that whitening causes enamel thinning and dental caries, and consider alternative whitening methods effective (all $p < 0.05$). Educational level was associated with both whitening-related perceptions and behavioral practices, although the specific pattern of associations varied across questionnaire items. Participants with lower educational attainment reported greater use of alternative whitening methods, whereas those with higher educational attainment relied more frequently on dentists for information and reported lower use of alternative methods ($p < 0.05$). Over-the-counter whitening toothpaste/gel was the most commonly reported whitening approach across all educational groups. In the exploratory item-by-item analysis, 55 of 78 pairwise associations were significant after Bonferroni adjustment, but almost all were of small magnitude; the strongest were between the two harm-related beliefs ($V = 0.443$) and between the two safety perceptions ($V = 0.320$).

Conclusions Misconceptions regarding tooth whitening remain common despite dentists being the primary information source. Gender was associated with a broader range of whitening-related beliefs and behaviors, whereas educational level showed associations with selected perceptions and behavioral practices. These findings emphasize the need for evidence-based patient education and improved oral health communication to counter misinformation and promote safe tooth-whitening practices.

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Keywords Tooth whitening · Public awareness · Oral health literacy · Misconceptions · Alternative whitening methods

Background

The growing emphasis on facial aesthetics has substantially increased demand for tooth whitening in recent years. Whiter teeth are commonly associated with youthfulness, attractiveness, health, and self-confidence, making tooth whitening one of the most frequently requested esthetic dental procedures [1, 2].

In response to this growing demand, a wide range of tooth-whitening approaches has become readily available to the public. In addition to professionally supervised bleaching procedures, over-the-counter (OTC) products, including whitening toothpastes, strips, gels, and mouthrinses, have become increasingly popular because of their easy accessibility, relatively low cost, and widespread commercial availability [3, 4]. In an effort to further reduce treatment costs and improve convenience, many individuals also turn to alternative whitening methods involving ingredients such as lemon, baking soda, apple cider vinegar, activated charcoal, coconut oil, strawberries, and various herbal preparations [5–8]. The widespread dissemination of these alternative whitening methods through internet and social media platforms has further accelerated their popularity, giving rise to a growing "do-it-yourself" (DIY) whitening trend. However, many of these approaches are promoted primarily based on anecdotal claims rather than scientific evidence, and concerns remain regarding their efficacy and potential adverse effects on dental hard tissues [5, 7, 9].

Previous cross-sectional surveys have consistently shown that, despite the increasing popularity of tooth whitening, public knowledge regarding its effectiveness, safety, and appropriate use remains limited. Awareness and use of whitening products are generally high, yet misconceptions regarding treatment safety and alternative whitening methods remain common [10–12]. Furthermore, demographic factors such as gender and educational level have been linked to variations in whitening-related knowledge, attitudes, and behaviors [10, 13]. Previous research has also demonstrated that oral health literacy is associated with oral health knowledge, preventive behaviors, and treatment-related decision-making, and that these relationships may differ according to gender and educational level [14, 15]. However, limited evidence is available regarding whether these demographic factors are specifically associated with misconceptions and behavioral preferences related to alternative whitening methods, highlighting an important gap in the current literature.

Therefore, this cross-sectional survey aimed to evaluate public awareness, information sources, treatment preferences, safety perceptions, and common myths regarding tooth whitening, as well as to investigate whether these perceptions differed according to gender and educational level. While hypotheses regarding gender and educational level were pre-specified, item-level subgroup comparisons were conducted within an exploratory framework to generate further hypotheses.

The study was tested under the following hypotheses:

$H_0$1: Gender does not significantly influence patients' beliefs in common myths and their behavioral choices regarding alternative whitening methods.

$H_0$2: Educational level does not significantly influence patients' beliefs in common myths and their behavioral choices regarding alternative whitening methods.

Materials and methods

Study design and ethical approval

This cross-sectional survey was conducted to evaluate public awareness, knowledge, preferences, and common myths regarding tooth whitening. Before the initiation of the study, official ethical approval was obtained from the Istanbul Kent University Faculty of Dentistry Non-Interventional Clinical and Observational Research Ethics Committee (Approval No: E-47854390-200-55894, Date: 04.03.2026). The study was conducted in strict accordance with the ethical principles outlined in the Declaration of Helsinki.

Sample size calculation

Sample size was determined by an a priori power analysis using G*Power software (Version 3.1.9.7, Heinrich Heine University, Düsseldorf, Germany). The sample size calculation was based on the primary planned chi-square test of independence for contingency tables. A medium effect size (Cohen's w = 0.30), according to Cohen's conventional effect size classification, a significance level (α) of 0.05, a statistical power of 80% (1 − β = 0.80), and 12 degrees of freedom were specified [16]. The analysis indicated a minimum required sample size of 193 participants. A total of 532 individuals were ultimately included in the study, substantially exceeding this minimum and ensuring adequate statistical power for the planned analyses.

Participants and selection criteria

The study included adults (both Turkish citizens and foreign nationals) residing in Türkiye. Participants were recruited using a convenience sampling approach from adult patients attending the Istanbul Kent University Oral and Dental Health Education, Application, and Research Center, as well as their accompanying relatives, between March and May 2026. To evaluate genuine public knowledge and myths independent of professional bias, dental students and dental professionals were strictly excluded. Participation was entirely voluntary, and informed consent was obtained prior to questionnaire completion. Individuals younger than 18 years of age and questionnaires with incomplete responses were also excluded. Of the 578 questionnaires returned, 46 were excluded due to missing data, resulting in a final sample of 532 participants. Because the total number of eligible individuals approached was not recorded during recruitment, a formal response rate could not be calculated.

Survey content

The authors developed the questionnaire following a comprehensive review of the literature on tooth whitening, including public awareness, treatment preferences, safety perceptions, and common misconceptions. In addition to items adapted from previously published studies, new questions were developed to assess beliefs and behaviors related to alternative whitening methods that were considered clinically relevant but insufficiently addressed in the existing literature.

To establish face and content validity, the preliminary questionnaire was independently evaluated by two faculty members specializing in Restorative Dentistry regarding item clarity, relevance, and comprehensibility. Based on their expert feedback, minor revisions were made to improve item wording and logical ordering. The revised version was subsequently pilot-tested on 30 individuals representative of the target population (who were excluded from the final analysis) to assess overall comprehensibility and response feasibility. The pilot study indicated that the questionnaire was easy to understand; however, based on participant feedback, minor adjustments were made to the response formats—specifically changing selected single-response questions to a multiple-response format where multiple choices could reasonably coexist.

No formal quantitative content validity testing (e.g., Content Validity Index [CVI]), internal consistency, or test–retest reliability assessments were performed, as the questionnaire comprised independent, non-cognitive items addressing distinct domain aspects of tooth whitening rather than a single latent psychological construct.

The final questionnaire consisted of 19 items (presented in Additional file 1). The first section collected demographic information, including gender, age, and educational level. The remaining sections evaluated participants' information sources, treatment preferences, awareness of professional and alternative whitening methods, safety perceptions, and common myths related to tooth whitening. Unless otherwise specified, responses were recorded using a three-point nominal scale ("Yes", "No", "No opinion"), whereas selected questions permitted multiple responses.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics (Version 31.0; IBM Corp., Armonk, NY, USA). Statistical significance was set at $\alpha = 0.05$. Descriptive statistics were presented as frequencies (n) and percentages (%). Associations between participants' responses and the independent variables (gender and educational level) were analyzed separately.

For single-response categorical variables, the three response categories ("Yes", "No", and "No opinion") were treated as independent nominal categories without merging or collapsing them, and associations were evaluated using the Pearson chi-square (χ^2) test.

Effect sizes were reported as Cramer's V. For questionnaire items allowing multiple responses, the overall association between response patterns and demographic variables was assessed using the Rao–Scott corrected chi-square test. Individual response options were subsequently evaluated using Pearson chi-square tests, and differences between proportions were assessed using Bonferroni-adjusted z-tests. Item Q10 was conditional upon an affirmative response to Q9 and was therefore analyzed only among participants who answered 'Yes' to Q9. In the tables, categories sharing the same superscript letters did not differ significantly, whereas categories with different superscript letters indicated statistically significant differences.

In addition to the planned comparisons by gender and educational level, the associations among the questionnaire items themselves were examined in an exploratory manner. As all questionnaire variables were categorical, conventional correlation coefficients (Pearson's r, Spearman's rho) were not applicable; pairwise associations between all single-response items (Q5–Q9, Q11 and Q13–Q19) were therefore assessed using Pearson chi-square tests of independence, with Cramer's V as the corresponding measure of association for nominal categorical variables (0.10, 0.30 and 0.50 were interpreted as small, moderate and large effects, respectively). Because 78 pairwise tests were performed, statistical significance for this exploratory matrix was evaluated against a Bonferroni-adjusted threshold of $p < 0.00064$ (0.05/78). The multiple-response items (Q4, Q10 and Q12) were not included in this matrix, as Cramer's V is not defined for non-mutually exclusive response sets.

Results

The demographic distribution of the participants ($n = 532$) is presented in Table 1.

Information sources, perceptions, and previous tooth-whitening experience

The distribution of participants' information sources, self-confidence perceptions, and previous tooth-whitening experience according to gender and educational level is presented in Tables 2 and 3. A significant gender difference was observed in the sources used to obtain whitening-related information (Q4) ($\chi^2 = 36.18$, $p < 0.001$). Dentists were the primary source of information for females (65.03%), significantly more frequently than for males (47.09%), whereas males relied more frequently on television/newspapers (12.62%). No significant gender

Table 1 Demographic profile

Demographic Characteristics	Count	*n* %
Gender		
Female	326	61.28%
Male	206	38.72%
Age		
18–24	113	21.24%
25–34	162	30.45%
35–44	99	18.61%
45–54	63	11.84%
55+	95	17.86%
Education Level		
Illiterate	14	2.63%
Primary School	46	8.65%
Middle School	37	6.95%
High School	123	23.12%
Associate Degree	66	12.41%
Bachelor's Degree	155	29.14%
Postgraduate	91	17.11%
Total	532	100.00%

differences were found for social media or friends/family. Educational level significantly influenced the use of dentists as an information source, with participants holding bachelor's and postgraduate degrees reporting dentists as their primary source more frequently than those with lower educational attainment ($p < 0.05$).

Regarding the belief that white teeth increase self-confidence (Q5), females agreed more frequently than males (73.01% vs. 56.31%; $\chi^2=16.00$, $p<0.001$, Cramer's V=0.173). Across educational levels, agreement was highest among bachelor's degree holders (76.13%) and lowest among middle school graduates (35.14%), who also showed the highest proportion of disagreement (54.05%).

For previous professional whitening experience (Q6), the overall response distribution differed significantly according to gender ($\chi^2=14.53$, $p<0.001$); however, the proportion of participants reporting previous professional tooth-whitening experience did not differ significantly between females and males (31.90% vs. 30.58%). The observed gender difference was primarily attributable to the higher proportion of male participants selecting the "No opinion" response. Educational level was not associated with previous professional tooth-whitening experience, with the majority of participants across all educational groups (56.52%–68.13%) reporting no previous treatment.

Perceptions of harm and alternative methods

Gender significantly influenced perceptions of the safety and biological effects of tooth whitening. Females were more likely than males to believe that whitening damages tooth structure (Q7) (46.01% vs. 33.98%; $\chi^2=7.79$, $p=0.020$). Similarly, females more frequently believed that whitening causes enamel thinning and increases susceptibility to dental caries (Q8) (50.00% vs. 39.32%; $\chi^2=6.61$, $p=0.037$). These perceptions did not differ significantly across educational levels.

Regarding the belief that substances such as lemon, baking soda or vinegar have a whitening effect (Q9), females endorsed this belief more frequently than males (38.96% vs. 27.67%; $\chi^2=10.89$, $p=0.004$). Educational level had no significant effect on this belief.

No overall gender difference was observed in the sources from which participants gained information regarding alternative whitening methods (Q10) ($p=0.622$). At the individual response-option level, however, males relied more frequently on recommendations from acquaintances or relatives than females (58.93% vs. 42.98%), whereas social media use was comparable between genders. Across educational groups, only social media use

Table 2 Comparison of participants' knowledge, perceptions, and experiences regarding tooth whitening based on gender

Questions	Options	Female ($n=326$)	Male ($n=206$)	Total ($n=532$)	$\chi 2$	p	Cramer's V
Q4. Information sources about tooth whitening	Dentist	212 (65.03%)[a]	97 (47.09%)[b]	309 (58.08%)	36.18	<0.001*	—
	Social media	106 (32.52%)[a]	86 (41.75%)[a]	192 (36.09%)			
	Friends / Family	70 (21.47%)[a]	54 (26.21%)[a]	124 (23.31%)			
	Television / Newspaper	16 (4.91%)[a]	26 (12.62%)[b]	42 (7.89%)			
	None	29 (8.90%)[a]	28 (13.59%)[a]	57 (10.71%)			
Q5. White teeth increase self-confidence	Yes	238 (73.01%)[a, A]	116 (56.31%)[b, A]	354 (66.54%)	16.00	<0.001*	0.173
	No	50 (15.34%)[a, B]	54 (26.21%)[b, B]	104 (19.55%)			
	No opinion	38 (11.66%)[a, B]	36 (17.48%)[a, B]	74 (13.91%)			
Q6. Previous professional whitening experience	Yes	104 (31.90%)[a, A]	63 (30.58%)[a, A]	167 (31.39%)	14.53	<0.001*	0.165
	No	213 (65.34%)[a, B]	121 (58.74%)[a, A]	334 (62.78%)			
	No opinion	9 (2.76%)[a, B]	22 (10.68%)[b, B]	31 (5.83%)			
Q7. Whitening damages the teeth	Yes	150 (46.01%)[a, A]	70 (33.98%)[b, A]	220 (41.35%)	7.79	0.020*	0.121
	No	96 (29.45%)[a, B]	78 (37.86%)b· [B]	174 (32.71%)			
	No opinion	80 (24.54%)[a, AB]	58 (28.16%)[a, AB]	138 (25.94%)			
Q8. Whitening thins enamel and increases caries risk	Yes	163 (50.00%)[a, A]	81 (39.32%)[b, A]	244 (45.86%)	6.61	0.037*	0.111
	No	88 (26.99%)[a, B]	74 (35.92%)[b, B]	162 (30.45%)			
	No opinion	75 (23.01%)[a, AB]	51 (24.76%)[a, AB]	126 (23.68%)			
Q9. Lemon, baking soda or vinegar have a whitening effect	Yes	127 (38.96%)[a, A]	57 (27.67%)[b, A]	184 (34.59%)	10.89	0.004*	0.143
	No	141 (43.25%)[a, AB]	91 (44.17%)[a, AB]	232 (43.61%)			
	No opinion	58 (17.79%)[a, B]	58 (28.16%)[b, B]	116 (21.80%)			
Q10. Source of the belief in alternative methods	Recommendation of acquaintances/ relatives	52 (42.98%)[a]	33 (58.93%)[b]	85 (48.02%)	1.77	0.622	—
	Social media	62 (51.24%)[a]	25 (44.64%)[a]	87 (49.15%)			
	Other ways	37 (30.58%)[a]	13 (23.21%)[a]	50 (28.25%)			
Q11. Personal use of alternative whitening methods	Yes	97 (29.75%)[a, A]	51 (24.76%)[a, A]	148 (27.82%)	19.21	<0.001*	0.190
	No	216 (66.26%)[a, A]	125 (60.68%)[a, B]	341 (64.10%)			
	No opinion	13 (3.99%)[a, B]	30 (14.56%)[b, B]	43 (8.08%)			
Q12. Methods used to whiten own teeth	Professional whitening by a dentist	97 (29.75%)[a]	67 (32.52%)[a]	164 (30.83%)	7.54	0.581	—
	Over-the-counter (OTC) whitening toothpaste, gel, or powder	143 (43.87%)[a]	75 (36.41%)[a]	218 (40.98%)			
	Baking soda	43 (13.19%)[a]	27 (13.11%)[a]	70 (13.16%)			
	Lemon	26 (7.98%)[a]	23 (11.17%)[a]	49 (9.21%)			
	Salt	41 (12.58%)[a]	27 (13.11%)[a]	68 (12.78%)			
	Activated charcoal	28 (8.59%)[a]	12 (5.83%)[a]	40 (7.52%)			
	Herbal mixtures (e.g., turmeric, coconut oil, etc.)	28 (8.59%)[a]	15 (7.28%)[a]	43 (8.08%)			
	Other substances	23 (7.06%)[a]	18 (8.74%)[a]	41 (7.71%)			
	None	76 (23.31%)[a]	43 (20.87%)[a]	119 (22.37%)			
Q13. Whitening effect is permanent	Yes	40 (12.27%)[a, A]	41 (19.90%)[b, A]	81 (15.23%)	8.37	0.015*	0.125
	No	229 (70.25%)[a, B]	121 (58.74%)[b, B]	350 (65.79%)			
	No opinion	57 (17.48%)[a, AB]	44 (21.36%)[a, AB]	101 (18.98%)			
Q14. Chemicals used in professional whitening are safe	Yes	101 (30.98%)	62 (30.10%)	163 (30.64%)	1.88	0.390	0.059
	No	123 (37.73%)	89 (43.20%)	212 (39.85%)			
	No opinion	102 (31.29%)	55 (26.70%)	157 (29.51%)			
Q15. Whitening products sold in pharmacies/markets are safe	Yes	82 (25.15%)	63 (30.58%)	145 (27.26%)	2.02	0.363	0.062
	No	147 (45.09%)	89 (43.20%)	236 (44.36%)			
	No opinion	97 (29.75%)	54 (26.21%)	151 (28.38%)			
Q16. Tooth whitening is expensive	Yes	208 (63.80%)[a, A]	105 (50.97%)[b, A]	313 (58.83%)	10.49	0.005*	0.140
	No	42 (12.88%)[a, B]	45 (21.84%)[b, B]	87 (16.35%)			
	No opinion	76 (23.31%)[a, AB]	56 (27.18%)[a, AB]	132 (24.81%)			

Table 2 (continued)

Questions	Options	Female ($n=326$)	Male ($n=206$)	Total ($n=532$)	$\chi 2$	p	Cramer's V
Q17. Long-term use of whitening toothpaste damages enamel	Yes	223 (68.40%)$^{a, A}$	119 (57.77%)$^{b, A}$	342 (64.29%)	6.53	0.038*	0.111
	No	48 (14.72%)$^{a, A}$	44 (21.36%)$^{b, B}$	92 (17.29%)			
	No opinion	55 (16.87%)$^{a, A}$	43 (20.87%)$^{a, AB}$	98 (18.42%)			
Q18. Whitening performed without a dentist is risky	Yes	232 (71.17%)	133 (64.56%)	365 (68.61%)	3.53	0.171	0.081
	No	47 (14.42%)	42 (20.39%)	89 (16.73%)			
	No opinion	47 (14.42%)	31 (15.05%)	78 (14.66%)			
Q19. Awareness that discoloration may recur after whitening	Yes	266 (81.60%)$^{a, A}$	140 (67.96%)$^{b, A}$	406 (76.32%)	16.21	<0.001*	0.175
	No	19 (5.83%)$^{a, B}$	31 (15.05%)$^{b, B}$	50 (9.40%)			

The lowercase superscript letters represent statistically significant differences between rows, while the uppercase letters represent differences between columns

differed significantly, with high school graduates reporting higher adoption rates than university graduates. No other educational differences were identified.

For the personal use of alternative whitening methods (Q11), the overall response distribution differed significantly according to both gender and educational level ($p<0.001$). However, the prevalence of previous use of alternative whitening methods did not differ significantly between females and males (29.75% vs. 24.76%). The observed gender difference in the overall response distribution was primarily attributable to the higher proportion of male participants selecting the "No opinion" response. In contrast, primary school graduates reported the highest prevalence of previous use of alternative whitening methods (43.48%), whereas postgraduate participants reported the lowest prevalence (12.09%).

Regarding the methods participants had used to whiten their own teeth (Q12), OTC whitening toothpaste/gel was the most commonly reported whitening approach across all educational groups, followed by professionally supervised whitening procedures. Educational level significantly influenced only lemon use, which was reported significantly less frequently by postgraduate participants than by high school graduates ($p<0.05$).

Perceptions of treatment longevity, safety, and cost

Participants' perceptions of treatment longevity, cost, and safety also varied by gender. Regarding the belief that the whitening effect is permanent (Q13), males were more likely than females to believe that whitening results are permanent (19.90% vs. 12.27%; $\chi^2=8.37$, $p=0.015$). Participants with bachelor's (76.77%) and postgraduate degrees (75.82%) more frequently reported that whitening results were not permanent, whereas half of the illiterate participants (50.00%; 7 of 14) believed the results to be permanent.

No significant gender differences were observed in perceptions of the safety of professional whitening materials (Q14, $p=0.390$) or OTC whitening products (Q15, $p=0.363$).

Females were significantly more likely than males to consider tooth whitening treatments expensive (Q16) (63.80% vs. 50.97%; $\chi^2=10.49$, $p=0.005$), whereas males more frequently believed that treatment costs were not high. Females more frequently believed that prolonged use of whitening toothpastes may damage enamel (Q17) (68.40% vs. 57.77%; $\chi^2=6.53$, $p=0.038$) and that tooth discoloration may recur after whitening treatment (Q19) (81.60% vs. 67.96%; $\chi^2=16.21$, $p<0.001$).

Finally, no significant gender difference was found regarding the perceived risks of whitening performed without professional supervision (Q18). Most participants in both groups agreed that whitening procedures performed without a dentist's supervision may pose clinical risks.

Table 3 Comparison of participants' knowledge, perceptions, and experiences regarding tooth whitening based on education level

Questions	Options	Illiterate($n=14$)	Primary School($n=46$)	Middle School($n=37$)	High School($n=123$)	Associate Degree($n=66$)	Bachelor's Degree($n=155$)	Postgraduate($n=91$)	TOTAL($n=532$)	$\chi 2$	p	Cramer's V
Q4. Information sources about tooth whitening	Dentist	5 (35.71%)[ab]	16 (34.78%)[b]	12 (32.43%)[b]	74 (60.16%)[ab]	39 (59.09%)[ab]	105 (67.74%)[a]	58 (63.74%)[a]	309 (58.08%)	71.81	<0.001*	—
	Social media	1 (7.14%)[a]	20 (43.48%)[a]	17 (45.95%)[a]	43 (34.96%)[a]	27 (40.91%)[a]	57 (36.77%)[a]	27 (29.67%)[a]	192 (36.09%)			
	Friend/ Family	4 (28.57%)[a]	9 (19.57%)[a]	12 (32.43%)[a]	26 (21.14%)[a]	18 (27.27%)[a]	43 (27.74%)[a]	12 (13.19%)[a]	124 (23.31%)			
	Television/ Newspaper	3 (21.43%)[a]	2 (4.35%)[a]	5 (13.51%)[a]	9 (7.32%)[a]	7 (10.61%)[a]	12 (7.74%)[a]	4 (4.40%)[a]	42 (7.89%)			
	None	3 (21.43%)[a]	7 (15.22%)[a]	3 (8.11%)[a]	11 (8.94%)[a]	3 (4.55%)[a]	13 (8.39%)[a]	17 (18.68%)[a]	57 (10.71%)			
Q5. White teeth increase self-confidence	Yes	10 (71.43%) abc, A	21 (45.65%) bc, A	13 (35.14%) c, A	84 (68.29%) ab, A	47 (71.21%) ab, A	118 (76.13%) a, A	61 (67.03%)ab, A	354 (66.54%)	52.08	<0.001*	0.221
	No	1 (7.14%) abc, A	17 (36.96%) bc, B	20 (54.05%) c, B	21 (17.07%) ab, B	13 (19.70%) ab, B	19 (12.26%) a, B	13 (14.29%)ab, B	104 (19.55%)			
	No opinion	3 (21.43%) ab, A	8 (17.39%) a, B	4 (10.81%) a, A	18 (14.63%) a, B	6 (9.09%)a, B	18 (11.61%) a, AB	17 (18.68%)a, B	74 (13.91%)			
Q6. Previous professional whitening experience	Yes	3 (21.43%)a, A	18 (39.13%) a, A	11 (29.73%) a, A	34 (27.64%) a, A	20 (30.30%) a, A	53 (34.19%) a, A	23 (25.27%)a, A	167 (31.39%)	19.33	0.081	0.135
	No	8 (57.14%)a, B	26 (56.52%) a, B	23 (62.16%) a, B	82 (66.67%) a, B	41 (62.12%) a, B	97 (62.58%) a, B	62 (68.13%)a, B	334 (62.78%)			
	No opinion	3 (21.43%) ab, A	2 (4.35%) ab, A	3 (8.11%) ab, A	7 (5.69%)ab, A	5 (7.58%) ab, A	5 (3.23%)b, A	6 (6.59%)ab, A	31 (5.83%)			
Q7. Whitening damages the teeth	Yes	5 (35.71%)	19 (41.30%)	14 (37.84%)	39 (31.71%)	32 (48.48%)	69 (44.52%)	42 (46.15%)	220 (41.35%)	13.68	0.322	0.113
	No	3 (21.43%)	18 (39.13%)	14 (37.84%)	48 (39.02%)	21 (31.82%)	42 (27.10%)	28 (30.77%)	174 (32.71%)			
	No opinion	6 (42.86%)	9 (19.57%)	9 (24.32%)	36 (29.27%)	13 (19.70%)	44 (28.39%)	21 (23.08%)	138 (25.94%)			
Q8. Whitening thins enamel and increases caries risk	Yes	6 (42.86%)	19 (41.30%)	16 (43.24%)	52 (42.28%)	31 (46.97%)	80 (51.61%)	40 (43.96%)	244 (45.86%)	12.15	0.434	0.107
	No	3 (21.43%)	19 (41.30%)	12 (32.43%)	39 (31.71%)	25 (37.88%)	36 (23.23%)	28 (30.77%)	162 (30.45%)			
	No opinion	5 (35.71%)	8 (17.39%)	9 (24.32%)	32 (26.02%)	10 (15.15%)	39 (25.16%)	23 (25.27%)	126 (23.68%)			
Q9. Lemon, baking soda or vinegar have a whitening effect	Yes	8 (57.14%)	17 (36.96%)	15 (40.54%)	52 (42.28%)	23 (34.85%)	46 (29.68%)	23 (25.27%)	184 (34.59%)	13.41	0.340	0.112
	No	3 (21.43%)	19 (41.30%)	15 (40.54%)	47 (38.21%)	28 (42.42%)	76 (49.03%)	44 (48.35%)	232 (43.61%)			
	No opinion	3 (21.43%)	10 (21.74%)	7 (18.92%)	24 (19.51%)	15 (22.73%)	33 (21.29%)	24 (26.37%)	116 (21.80%)			

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Table 3 (continued)

Questions	Options	Illiterate($n=14$)	Primary School($n=46$)	Middle School($n=37$)	High School($n=123$)	Associate Degree($n=66$)	Bachelor's Degree($n=155$)	Postgraduate($n=91$)	TOTAL($n=532$)	$\chi 2$	p	Cramer's V
Q10. Source of the belief in alternative methods	Advice from acquaintances/ relatives	7 (87.50%)[a]	4 (25.00%)[a]	8 (57.14%)[a]	22 (42.31%)[a]	11 (50.00%)[a]	23 (52.27%)[a]	10 (47.62%)[a]	85 (48.02%)	33.27	0.015*	—
	Social media	3 (37.50%)[ab]	10 (62.50%)[ab]	4 (28.57%)[ab]	34 (65.38%)[b]	12 (54.55%)[ab]	14 (31.82%)[a]	10 (47.62%)[ab]	87 (49.15%)			
	Other ways	4 (50.00%)[a]	4 (25.00%)[a]	4 (28.57%)[a]	11 (21.15%)[a]	8 (36.36%)[a]	11 (25.00%)[a]	8 (38.10%)[a]	50 (28.25%)			
Q11. Personal use of alternative whitening methods	Yes	3 (21.43%) ab, B	20 (43.48%) ab, B	11 (29.73%) ab, AB	38 (30.89%) b, A	18 (27.27%) ab, A	47 (30.32%) b, A	11 (12.09%)a, A	148 (27.82%)	35.86	<0.001*	0.184
	No	7 (50.00%) ab, B	22 (47.83%) b, B	19 (51.35%) b, B	76 (61.79%) b, A	43 (65.15%) ab, A	99 (63.87%) b, A	75 (82.42%)a, B	341 (64.10%)			
	No opinion	4 (28.57%)a, A	4 (8.70%) ab, A	7 (18.92%) ab, A	9 (7.32%)ab, A	5 (7.58%) ab, A	9 (5.81%)b, A	5 (5.49%)ab, A	43 (8.08%)			
Q12. Methods used to whiten own teeth	Professional whitening	4 (28.57%)[a]	12 (26.09%)[a]	16 (43.24%)[a]	33 (26.83%)[a]	25 (37.88%)[a]	45 (29.03%)[a]	29 (31.87%)[a]	164 (30.83%)	88.27	0.002*	—
	Whitening toothpaste/ gel	7 (50.00%)[a]	13 (28.26%)[a]	13 (35.14%)[a]	49 (39.84%)[a]	25 (37.88%)[a]	73 (47.10%)[a]	38 (41.76%)[a]	218 (40.98%)			
	Baking soda	2 (14.29%)[a]	11 (23.91%)[a]	7 (18.92%)[a]	18 (14.63%)[a]	10 (15.15%)[a]	15 (9.68%)[a]	7 (7.69%)[a]	70 (13.16%)			
	Lemon	2 (14.29%)[ab]	6 (13.04%)[ab]	3 (8.11%)[ab]	18 (14.63%)[b]	8 (12.12%)[ab]	10 (6.45%)[ab]	2 (2.20%)[a]	49 (9.21%)			
	Salt	1 (7.14%)[a]	7 (15.22%)[a]	4 (10.81%)[a]	24 (19.51%)[a]	13 (19.70%)[a]	14 (9.03%)[a]	5 (5.49%)[a]	68 (12.78%)			
	Activated charcoal	1 (7.14%)[a]	4 (8.70%)[a]	5 (13.51%)[a]	8 (6.50%)[a]	3 (4.55%)[a]	13 (8.39%)[a]	6 (6.59%)[a]	40 (7.52%)			
	Herbal mixtures	2 (14.29%)[a]	7 (15.22%)[a]	6 (16.22%)[a]	14 (11.38%)[a]	5 (7.58%)[a]	6 (3.87%)[a]	3 (3.30%)[a]	43 (8.08%)			
	Other substances	3 (21.43%)[a]	6 (13.04%)[ab]	4 (10.81%)[ab]	9 (7.32%)[ab]	8 (12.12%)[ab]	9 (5.81%)[ab]	2 (2.20%)[b]	41 (7.71%)			
	None	2 (14.29%)[a]	8 (17.39%)[a]	6 (16.22%)[a]	27 (21.95%)[a]	13 (19.70%)[a]	35 (22.58%)[a]	28 (30.77%)[a]	119 (22.37%)			

Table 3 (continued)

Questions	Options	Illiterate($n=14$)	Primary School($n=46$)	Middle School($n=37$)	High School($n=123$)	Associate Degree($n=66$)	Bachelor's Degree($n=155$)	Postgraduate($n=91$)	TOTAL($n=532$)	$\chi 2$	p	Cramer's V
Q13. Whitening effect is permanent	Yes	7 (50.00%)a, A	13 (28.26%) ab, A	10 (27.03%) abc, A	21 (17.07%) abc, A	8 (12.12%) bc, A	14 (9.03%)c, A	8 (8.79%)bc, A	81 (15.23%)	53.08	<0.001*	0.223
	No	1 (7.14%)a, B	21 (45.65%) ab, B	17 (45.95%) ab, B	80 (65.04%) bc, B	43 (65.15%) bc, A	119 (76.77%) c, B	69 (75.82%)c, B	350 (65.79%)			
	No opinion	6 (42.86%) a, AB	12 (26.09%) ab, AB	10 (27.03%) ab, AB	22 (17.89%) a, AB	15 (22.73%) a, A	22 (14.19%) a, AB	14 (15.38%)a, AB	101 (18.98%)			
Q14. Chemicals used in professional whitening are safe	Yes	3 (21.43%)	13 (28.26%)	8 (21.62%)	43 (34.96%)	25 (37.88%)	44 (28.39%)	27 (29.67%)	163 (30.64%)	16.76	0.159	0.126
	No	5 (35.71%)	22 (47.83%)	19 (51.35%)	35 (28.46%)	29 (43.94%)	63 (40.65%)	39 (42.86%)	212 (39.85%)			
	No opinion	6 (42.86%)	11 (23.91%)	10 (27.03%)	45 (36.59%)	12 (18.18%)	48 (30.97%)	25 (27.47%)	157 (29.51%)			
Q15. Whitening products sold in pharmacies/ markets are safe	Yes	8 (57.14%)a, A	15 (32.61%) ab, AB	14 (37.84%) ab, AB	38 (30.89%) ab, A	24 (36.36%) a, A	30 (19.35%) b, A	16 (17.58%)b, A	145 (27.26%)	27.76	0.006*	0.162
	No	2 (14.29%)a, B	19 (41.30%) a, A	11 (29.73%) a, B	48 (39.02%) a, A	27 (40.91%) a, A	77 (49.68%) b, B	52 (57.14%)a, B	236 (44.36%)			
	No opinion	4 (28.57%) a, AB	12 (26.09%) a, AB	12 (32.43%) a, AB	37 (30.08%) a, A	15 (22.73%) a, A	48 (30.97%) a, AB	23 (25.27%)a, AB	151 (28.38%)			
Q16. Tooth whitening is expensive	Yes	4 (28.57%)a, A	22 (47.83%) a, A	18 (48.65%) a, A	75 (60.98%) a, A	46 (69.70%) a, A	89 (57.42%) a, A	59 (64.84%)a, A	313 (58.83%)	31.31	0.002*	0.172
	No	5 (35.71%)a, B	16 (34.78%) a, B	7 (18.92%) ab, A	19 (15.45%) b, A	11 (16.67%) ab, A	23 (14.84%) b, A	6 (6.59%)b, B	87 (16.35%)			
	No opinion	5 (35.71%)a, B	8 (17.39%) a, A	12 (32.43%) a, A	29 (23.58%) a, A	9 (13.64%) a, A	43 (27.74%) a, A	26 (28.57%)a, AB	132 (24.81%)			
Q17. Long-term use of whitening toothpaste damages enamel	Yes	4 (28.57%)a, A	25 (54.35%) ab, A	21 (56.76%) ab, A	74 (60.16%) ab, A	39 (59.09%) ab, A	111 (71.61%) b, A	68 (74.73%)b, A	342 (64.29%)	26.34	0.010*	0.157
	No	6 (42.86%)a, A	14 (30.43%) ab, B	8 (21.62%) ab, A	21 (17.07%) ab, A	14 (21.21%) ab, A	19 (12.26%) b, A	10 (10.99%)b, B	92 (17.29%)			
	No opinion	4 (28.57%)a, A	7 (15.22%) a, A	8 (21.62%) a, A	28 (22.76%) a, A	13 (19.70%) a, A	25 (16.13%) a, A	13 (14.29%)a, AB	98 (18.42%)			
Q18. Whitening performed without a dentist is risky	Yes	7 (50.00%) ab, A	25 (54.35%) ab, A	18 (48.65%) b, A	83 (67.48%) ab, A	47 (71.21%) ab, A	117 (75.48%) a, A	68 (74.73%)ab, A	365 (68.61%)	30.23	0.003*	0.169
	No	4 (28.57%) abc, A	16 (34.78%) c, B	11 (29.73%) bc, B	20 (16.26%) ab, A	13 (19.70%) abc, A	16 (10.32%) a, B	9 (9.89%)ab, B	89 (16.73%)			
	No opinion	3 (21.43%)a, A	5 (10.87%) a, B	8 (21.62%) a, B	20 (16.26%) a, A	6 (9.09%)a, A	22 (14.19%) a, B	14 (15.38%)a, B	78 (14.66%)			

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Table 3 (continued)

Questions	Options	Illiterate($n=14$)	Primary School($n=46$)	Middle School($n=37$)	High School($n=123$)	Associate Degree($n=66$)	Bachelor's Degree($n=155$)	Postgraduate($n=91$)	TOTAL($n=532$)	$\chi 2$	p	Cramer's V
Q19. Awareness that discoloration may recur after whitening	Yes	7 (50.00%) ab, A	28 (60.87%) b, A	22 (59.46%) b, A	87 (70.73%) ab, A	50 (75.76%) abc, A	135 (87.10%) c, A	77 (84.62%)ac, A	406 (76.32%)	40.04	<0.001*	0.194
	No	3 (21.43%) ab, B	11 (23.91%) b, B	5 (13.51%) ab, B	12 (9.76%) ab, B	7 (10.61%) ab, B	7 (4.52%)a, B	5 (5.49%)ab, B	50 (9.40%)			
	No opinion	4 (28.57%)ab, AB	7 (15.22%) ab, B	10 (27.03%) b, B	24 (19.51%) ab, AB	9 (13.64%) ab, B	13 (8.39%)a, B	9 (9.89%)ab, B	76 (14.29%)			

The lowercase superscript letters represent statistically significant differences between rows, while the uppercase letters represent differences between columns

Associations among questionnaire items

The pairwise associations among the 13 single-response items are presented as a Cramer's V matrix in Table 4. Of the 78 item pairs tested, 55 remained statistically significant after Bonferroni adjustment ($p<0.00064$); however, the great majority of these associations were small in magnitude (V = 0.07–0.29), indicating that the items captured largely distinct aspects of whitening-related knowledge and belief rather than a single underlying construct.

The strongest association in the matrix was observed between the two harm-related beliefs, Q7 and Q8 (V = 0.443, $p<0.001$): participants who believed that whitening damages the teeth were also those who believed that it thins enamel and predisposes to caries. A moderate association was found between the two safety items, Q14 and Q15 (V = 0.320, $p<0.001$), indicating that the perceived safety of professionally applied whitening chemicals and that of over-the-counter products largely co-occurred. Belief in the efficacy of alternative whitening methods (Q9) was associated both with having actually used such methods (Q11; V = 0.276, $p<0.001$) and with the perceived safety of over-the-counter whitening products (Q15; V = 0.273, $p<0.001$), indicating that this misconception tended to co-occur with self-reported purchasing and self-treatment behaviors. Previous professional whitening experience (Q6) was likewise associated with previous use of alternative methods (Q11; V = 0.276, $p<0.001$), suggesting that individuals interested in whitening may use more than one whitening approach.

Awareness that discoloration may recur after whitening (Q19) was further associated with the more cautious, risk-aware items: Q17 (V = 0.294), Q18 (V = 0.286), Q16 (V = 0.276) and Q13 (V = 0.251) (all $p<0.001$). In other words, participants who recognized that whitening is neither permanent nor without cost were also those who were most alert to the risks of unsupervised whitening and of prolonged whitening-toothpaste use. Conversely, previous professional whitening experience (Q6) was not significantly associated with perceptions of cost (Q16), of prolonged whitening-toothpaste use (Q17) or of unsupervised whitening (Q18) after Bonferroni adjustment, indicating that having undergone treatment did not by itself correspond to a more accurate risk appraisal.

Discussion

The increasing popularity of tooth whitening has been accompanied by a growing diversity of whitening approaches and information sources, making public awareness and misconceptions an increasingly important public health issue. In the present study, gender significantly influenced beliefs regarding alternative whitening methods, whereas educational level was associated with both whitening-related perceptions and behavioral practices, with the pattern of associations varying across questionnaire items. Although the overall response distribution for Q11 varied by gender, the proportion of participants reporting prior use of alternative whitening methods did not differ significantly between females and males. Accordingly, the first null hypothesis ($H01$) was rejected, and the second null hypothesis ($H02$) was also rejected.

Internet-mediated communication, particularly via social media platforms, exerts a far more profound and immediate influence on user behavior compared to traditional mass media. Unfortunately, this high level of engagement facilitates the rapid spread of misinformation and distorted health advice [17]. Approximately 40% of health-related information shared on social media has been reported to be scientifically inaccurate, with a considerable proportion originating from duplicated or coordinated sources [18]. In dentistry, misleading information regarding esthetic procedures may encourage patients to adopt ineffective or potentially harmful whitening practices. In contrast, the present study identified dentists as the primary source of information regarding tooth whitening, particularly among females and individuals with higher educational attainment. This finding suggests that professional advice appears to remain the most trusted source of whitening-related information. This observation must, however, be interpreted in light of the recruitment setting. Participants were recruited from a university dental center and therefore represented individuals who already had contact with and access to dental professionals. Consequently, the prominence of dentists as the primary source of whitening-related information may, at least

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Table 4 Pairwise associations among single-response questionnaire items measured using Cramer's V ($n = 532$)

Item	Q5	Q6	Q7	Q8	Q9	Q11	Q13	Q14	Q15	Q16	Q17	Q18	Q19
Q5. White teeth increase self-confidence	—												
Q6. Previous professional whitening experience	0.153*	—											
Q7. Whitening damages the teeth	0.103	0.101	—										
Q8. Whitening thins enamel and increases caries risk	0.131	0.108	**0.443***	—									
Q9. Lemon, baking soda or vinegar have a whitening effect	0.130	0.197*	0.154*	0.197*	—								
Q11. Personal use of alternative whitening methods	0.171*	0.276*	0.077	0.111	0.276*	—							
Q13. Whitening effect is permanent	0.166*	0.208*	0.142*	0.151*	0.154*	0.228*	—						
Q14. Chemicals used in professional whitening are safe	0.143*	0.187*	0.202*	0.176*	0.162*	0.102	0.202*	—					
Q15. Whitening products sold in pharmacies/markets are safe	0.085	0.153*	0.195*	0.160*	0.273*	0.184*	0.280*	**0.320***	—				
Q16. Tooth whitening is expensive	0.209*	0.070	0.170*	0.167*	0.142*	0.121	0.183*	0.151*	0.108	—			
Q17. Long-term use of whitening toothpaste damages enamel	0.119	0.087	0.180*	0.189*	0.155*	0.071	0.146*	0.200*	0.133	0.229*	—		
Q18. Whitening performed without a dentist is risky	0.170*	0.072	0.148*	0.111	0.152*	0.092	0.092	0.185*	0.197*	0.224*	0.238*	—	
Q19. Awareness that discoloration may recur after whitening	0.177*	0.120	0.198*	0.197*	0.152*	0.118	0.251*	0.132	0.167*	0.276*	0.294*	0.286*	—

Values represent Cramer's V coefficients derived from Pearson's chi-square tests of independence. Only statistically significant associations after Bonferroni correction are indicated by an asterisk (*; $p < 0.00064$ for 78 pairwise comparisons). Cramer's V values of 0.10, 0.30 and 0.50 represent small, moderate and large effect sizes, respectively, according to Cohen. Values of 0.30 or above are shown in bold

in part, reflect the characteristics of the study population. Individuals who do not routinely attend dental clinics may rely on different sources of whitening-related information, such as social media, advertising, or advice from family and friends. Therefore, the present findings should not be generalized to the wider population without caution. Future community-based studies including individuals with limited or no contact with dental services are warranted to determine whether information sources and whitening-related beliefs differ in other population groups. Nevertheless, the high prevalence of misconceptions observed in the present study indicates that access to professional information alone may not be sufficient to eliminate persistent myths surrounding tooth whitening.

This finding is further supported by previous research evaluating tooth whitening information on social media platforms. A recent analysis of TikTok videos reported that most whitening-related content was of low to moderate quality and demonstrated limited reliability. The authors concluded that social media platforms cannot guarantee accurate, evidence-based information regarding tooth whitening and recommended that individuals seek advice from dental professionals rather than relying on popular online content [19]. These findings reinforce the importance of dentists as the most reliable source of evidence-based whitening information. However, given that modern users are heavy social media consumers, often viewing the internet as an extension of their identity, the dental community must proactively ensure that highly accessible, quality educational materials are available to counteract this content overload, which can otherwise impair patients' decision-making capabilities and harm their oral health-related quality of life [20, 21]. The critical role of digital communication channels is further highlighted by contemporary data from other developing nations, where being directly influenced by social media content was found to increase the likelihood of attempting a whitening treatment by more than fourfold, underscoring the powerful impact of online networks on cosmetic oral-health behaviors [22].

When interpreting the gender-related findings that contributed to the rejection of the first null hypothesis, several noteworthy differences in perceptions and behaviors emerged. Female participants more frequently believed that white teeth enhance self-confidence, supporting previous evidence that women generally place greater importance on dental esthetics [23]. This greater esthetic awareness may also explain why females were more likely to believe in the whitening efficacy of alternative whitening methods. At the same time, females more frequently perceived professional tooth whitening as potentially harmful and believed that it could lead to enamel thinning and an increased risk of dental caries. These findings suggest that female participants simultaneously exhibited greater interest in tooth whitening and greater concern regarding its possible adverse effects. This introduces a striking "awareness-behavior paradox" within dental public health; similar patterns have been identified internationally where young adults who were fully aware of severe potential consequences, such as severe sensitivity and enamel destruction, were paradoxically more likely to attempt non-professional whitening [22]. These findings suggest that awareness of potential risks alone may not necessarily discourage individuals from considering alternative whitening methods. In contrast, male participants were less likely to endorse these beliefs and more frequently selected the "no opinion" response for several items, which may reflect greater uncertainty or lower familiarity with whitening-related information rather than a clear difference in knowledge.

The persistence of misconceptions regarding alternative whitening methods observed in the present study is consistent with previous surveys reporting widespread public acceptance of alternative whitening methods despite the lack of scientific evidence supporting their efficacy. Ingredients such as lemon juice, baking soda, vinegar, activated charcoal, and various herbal preparations are frequently promoted through social media and informal communication channels as inexpensive and natural alternatives to professional bleaching. Crucially, the ongoing marketing of charcoal-containing dentifrices, falsely promoted as 'toxin-free' fluoride-free products, enhances their perceived authority on digital networks [24]. Similarly, Brooks et al. concluded that there is insufficient clinical evidence to support the whitening efficacy or safety claims of charcoal-containing dentifrices and advised clinicians to caution patients regarding their use [25, 26]. Therefore, the continued popularity of these methods likely reflects the influence of misinformation rather than evidence-based oral health knowledge.

A previous survey reported that the use of alternative whitening methods was significantly more common among women (33.6%) than men (14.1%) [13]. In the present study, although female participants also reported a higher prevalence of previous use than males (29.75% vs. 24.76%), this difference did not reach statistical

significance. This discrepancy may reflect differences in study populations and sociocultural characteristics between studies.

Despite the persistence of misconceptions regarding alternative whitening methods, commercially available whitening toothpastes and professionally supervised whitening procedures were the most frequently reported approaches. In contrast, the use of alternative whitening methods involving lemon, activated charcoal, and herbal mixtures remained relatively uncommon. This finding may indicate increasing public preference for products perceived as more accessible and safer than alternative whitening methods, although misconceptions regarding their effectiveness and safety still persist. The relatively widespread acceptance of OTC whitening products may also be influenced by commercial advertising and digital media, which frequently emphasize whitening efficacy while minimizing potential adverse effects [10].

Educational level was associated with both whitening-related perceptions and behavioral practices, although the specific pattern of associations varied across questionnaire items. Notably, participants with higher educational attainment reported a lower tendency to use alternative whitening methods, despite showing beliefs regarding their effectiveness that were comparable to those of less educated participants. One possible explanation is that individuals with higher educational attainment may be more likely to critically evaluate whitening-related information before adopting unsupported practices; however, this was not directly assessed in the present study. Similarly, previous studies have reported that university-educated individuals demonstrate greater knowledge and awareness regarding tooth whitening than those with lower educational attainment [10]. Nevertheless, the persistence of misconceptions across all educational groups suggests that formal education alone is insufficient to eliminate whitening-related myths. Similar findings have been reported previously, with individuals having lower educational attainment showing a greater tendency to use alternative whitening methods [13]. This association may, at least in part, be related to broader factors such as oral health literacy and socioeconomic status [27]. Individuals with lower educational attainment may be less likely to access or use evidence-based oral health information and may be more likely to seek inexpensive alternative whitening methods rather than professionally supervised whitening treatments. However, these factors were not directly assessed in the present study and therefore warrant further investigation.

Another notable finding was the persistence of misconceptions regarding the biological safety of tooth whitening procedures. A substantial proportion of participants believed that whitening permanently damages enamel or increases susceptibility to dental caries, despite considerable evidence demonstrating that professionally supervised bleaching procedures are safe when performed according to recommended clinical protocols. Although transient tooth sensitivity and gingival irritation may occur, current evidence indicates that these adverse effects are generally mild and reversible, with no permanent structural damage to enamel when evidence-based bleaching protocols are followed [28, 29].

The exploratory matrix of associations among the questionnaire items adds a further layer to this picture. Although 55 of the 78 item pairs reached significance after Bonferroni adjustment, almost all associations were of small magnitude, with several approaching the threshold for a moderate effect size, indicating that whitening-related beliefs did not form a single coherent construct but rather a set of loosely connected beliefs. Two patterns of association were nevertheless observed. The first involved the harm-related beliefs (Q7 and Q8) and, more weakly, the two safety items (Q14 and Q15). These associations suggest that perceptions regarding whitening-related harm and safety tended to co-occur and were expressed similarly for professionally applied and over-the-counter whitening products. The second involved belief in alternative whitening methods (Q9), which was associated both with their reported use (Q11) and with the perceived safety of over-the-counter whitening products (Q15), suggesting that this belief was reflected in self-reported use of alternative whitening methods. Taken together, whitening-related misconceptions appeared to occur in recognizable patterns rather than as entirely isolated beliefs, although the modest effect sizes indicate that these patterns are relatively weak. From a clinical perspective, awareness that discoloration recurs after whitening (Q19) co-occurred with more cautious perceptions regarding treatment cost, prolonged whitening-toothpaste use, and unsupervised whitening, whereas previous professional whitening experience (Q6) was not associated with these perceptions. These findings suggest

that improving patients' understanding of the expected longevity of whitening outcomes may represent a useful focus for future educational strategies. These analyses should be interpreted as exploratory because 78 pairwise comparisons were performed and, despite statistical significance, most associations were of small effect size. They are also cross-sectional and cannot establish directionality; therefore, they should be regarded as hypothesis-generating rather than confirmatory.

The present findings have important clinical implications for preventive dentistry and public oral health. Educational interventions should focus not only on improving awareness regarding professionally supervised whitening procedures but also on correcting persistent misconceptions surrounding alternative whitening methods. Because dentists remain the primary source of whitening-related information, evidence-based communication during routine dental visits may represent one of the most effective strategies for reducing misinformation and promoting safe whitening practices.

Despite its significant insights into public perceptions and behaviors regarding tooth whitening, this study has several limitations that should be acknowledged. First, the cross-sectional design inherently limits the ability to establish causal relationships between sociodemographic factors and the observed clinical beliefs. Second, participants were recruited using a convenience sampling approach from patients attending a single university dental center and their accompanying relatives in Istanbul, which may have introduced selection bias and restrict the generalizability of our findings to a broader national or global scale. Third, the data rely entirely on self-reported questionnaires, which may introduce social desirability bias or recall bias, particularly regarding past behavioral experiences such as active self-whitening attempts (Q11). Fourth, the relatively low participation rate among illiterate individuals compared to highly educated cohorts could limit the statistical power of some subgroup analyses regarding educational divides. Lastly, although gender and educational level were pre-specified as primary independent variables of interest, no formal correction for multiple comparisons was applied across the numerous questionnaire items. Consequently, these item-level subgroup comparisons should be regarded as exploratory and hypothesis-generating rather than confirmatory. Finally, because the analyses of the associations among the questionnaire items involved multiple pairwise comparisons among categorical variables in a cross-sectional dataset, the observed associations should likewise be interpreted as exploratory and do not imply causal relationships.

Future multicenter studies involving larger and more diverse populations are warranted to improve the generalizability of the findings. Longitudinal studies are also needed to evaluate how public awareness, beliefs, and whitening-related behaviors change over time. In addition, future research should investigate the effectiveness of educational interventions aimed at improving oral health literacy, evaluate strategies to counteract whitening-related misinformation disseminated through social media, and explore additional factors that may influence beliefs and decision-making regarding tooth whitening.

Conclusion

Within the limitations of this study, misconceptions regarding tooth whitening remain widespread despite the availability of professional information. Gender was associated with a broader range of whitening-related beliefs and behaviors, whereas educational level showed associations with selected perceptions and behavioral practices, including the reported use of alternative whitening methods. Although dentists were identified as the primary source of whitening-related information, misconceptions regarding treatment safety and alternative whitening methods persisted. These findings highlight the need for public health strategies aimed at improving oral health literacy, strengthening evidence-based communication, and reducing the dissemination of misinformation regarding tooth whitening through digital media.

Abbreviations

CVI Content Validity Index

DIY Do–It–Yourself
OTC Over–the–Counter
SPSS Statistical Package for the Social Sciences

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Authors' contributions EEK conceived and designed the study, developed the questionnaire, supervised the research, collected and interpreted the data, and drafted the manuscript. NA contributed to data collection, data interpretation, and manuscript revision. BAD performed the statistical analyses, contributed to data interpretation, and critically revised the manuscript for important intellectual content. All authors read and approved the final manuscript.

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

Declarations

Ethics approval and consent to participate The study protocol was approved by the Istanbul Kent University Faculty of Dentistry Non-Interventional Clinical and Observational Research Ethics Committee (Approval No: E-47854390-200-55894; Date: 04 March 2026). The study was conducted in accordance with the principles of the Declaration of Helsinki. Written informed consent was obtained from all participants prior to their participation in the study.

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