RESEARCH PAPER

Aesthetic Tolerance of Anterior Spacing, Crowding, Open Bite, and Deep Bite Among Laypeople: A Cross-Sectional Image-Based Survey

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Abstract

Background: Lay perceptions of anterior malocclusion influence treatment demand and may differ from professional assessments. Understanding the severity at which visible occlusal traits become unacceptable can support patient-centred orthodontic communication. **Aim:** To assess laypeople's aesthetic ratings and perceived orthodontic treatment need for coded images representing progressively altered spacing, crowding, anterior open bite, and deep bite. **Materials and methods:** This cross-sectional electronic survey included 78 respondents attending the dental outpatient setting of D Y Patil University School of Dentistry, Navi Mumbai. Participants rated 14 coded frontal intraoral images on a five-point scale from very unattractive to very attractive and indicated whether each image required orthodontic treatment. Frequencies, percentages, mean attractiveness scores, standard deviations, and chi-square goodness-of-fit tests were calculated. **Results:** The reference image S0 received the highest mean score (3.67±1.18), followed by mild crowding image C1 (3.58±1.03). The lowest scores were recorded for severe crowding C4 (1.92±1.15), severe deep bite D5 (2.09±1.08), and severe open bite O5 (2.13±1.44). Perceived treatment need increased from 25.6% for S0 and C1 to 87.2% for S4, 92.3% for C4, 82.1% for O5, and 100% for D5. Most image-specific response distributions were statistically significant ($p<0.001$). **Conclusion:** Lay aesthetic tolerance decreased as anterior irregularity became more pronounced, although the threshold differed by trait. Severe crowding and deep bite generated the strongest treatment demand, while mild spacing and crowding were comparatively acceptable.

Keywords: Dental Esthetics; Health Knowledge, Attitudes, Practice; Orthodontics; Patient Preference; Surveys and Questionnaires

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Introduction

Dental appearance contributes to self-image, social interaction, and the decision to seek orthodontic care. Although malocclusion is clinically evaluated through dental, skeletal, functional, and soft-tissue relationships, treatment demand is strongly influenced by how individuals perceive their own anterior occlusion. Self-perception of dental-facial appearance and attitudes toward treatment may discriminate treatment seekers more clearly than general psychological characteristics [1]. Systematic evidence further indicates that malocclusion is associated with oral health-related quality of life, although the magnitude of this relationship varies across populations and measurement approaches [2].

The visible anterior teeth often dominate an observer's immediate judgment of a smile. Aesthetic concern and self-esteem may therefore predict perceived impact more strongly than the anatomical severity of malocclusion alone [3]. Recent evidence among young adults also shows that increasing self-rated and clinician-rated treatment need is accompanied by greater psychosocial burden [4]. However, professional and lay judgments do not necessarily coincide because orthodontists apply diagnostic knowledge, whereas laypeople respond mainly to symmetry, alignment, tooth display, and the conspicuousness of a deviation.

Image-based studies permit isolated assessment of these visual cues. Frontal dental views can reveal a stronger aesthetic effect of anterior occlusion than full-face views because competing facial information is removed [5]. Recognition also differs between vertical traits: laypeople may readily detect anterior open bite but show greater tolerance for deep bite, particularly when they do not recognize the problem [6]. For crowding, minor incisor displacement may be accepted until a visible threshold is crossed [7], whereas conspicuous interdental spacing can receive low attractiveness ratings even when observers differ in professional background [8]. Cultural experience,

age, education, and prior exposure to orthodontic care may further modify such judgments [9].

Comparing several traits within one survey can clarify whether aesthetic tolerance changes consistently with increasing image severity and whether attractiveness ratings correspond to perceived treatment need. Such information may help distinguish clinically detectable deviation from a visually meaningful concern. Therefore, this study assessed laypeople's aesthetic responses to coded frontal intraoral images representing spacing, crowding, anterior open bite, and deep bite. It also examined the proportion recommending orthodontic treatment for each image and described changes across the coded severity sequence.

Materials and Methods

A cross-sectional, questionnaire-based survey was conducted among laypeople attending the dental outpatient setting of D Y Patil University School of Dentistry, Navi Mumbai. The study was conducted in accordance with recommendations for reporting observational studies [10]. Because the questionnaire was administered electronically, relevant principles for transparent reporting of web-based surveys were also considered [11]. Data collection was non-interventional and responses were recorded anonymously. Participation was voluntary, and the opening screen explained the purpose of the survey before respondents proceeded to the image-rating section.

Participants and sampling

The source population comprised individuals from the general population who attended the dental outpatient department during the survey period. Non-probability convenience sampling was used. Individuals were eligible when they were able to understand the questionnaire, view the displayed images, and provide independent responses. Dental and orthodontic professionals were excluded because professional training could systematically alter visual thresholds. Responses were also restricted to questionnaires containing the required demographic and image-rating fields.

The supplied a priori calculation was performed using OpenEpi version 3. A two-sided 95% confidence level, 80% power, a 1:1 comparison ratio, and anticipated contrasting response proportions of 40% and 86% produced continuity-corrected group estimates of 21 per category and a minimum total of 42. The operational target was increased to 100 to improve precision across the four planned occlusal-trait domains. The achieved analytical dataset contained 78 complete response sets. Because every respondent assessed the same image series, the final analysis was treated as a cross-sectional repeated-image rating survey and not as an unmatched case-control comparison.

Questionnaire and image set

The structured questionnaire was delivered through Google Forms. Its first section recorded age group, gender, and previous or current contact with orthodontic care. Age was categorized as younger than 18 years, 18-35 years, 36-50 years, and older than 50 years. Orthodontic consultation status was recorded as no previous consultation, previous consultation, planning to undergo treatment, or currently undergoing orthodontic treatment.

The electronic format paired every coded image with the same two response tasks. Respondents selected an attractiveness category and then recorded a yes/no judgment of treatment need. No diagnostic explanation, clinical consequence, or suggested treatment was displayed beside an image, separating the immediate visual response from professional information that could alter the rating.

The image-assessment section contained 14 coded frontal intraoral photographs. The code prefix identified the occlusal-trait series: S for spacing, C for crowding, O for anterior open bite, and D for deep bite. The evaluated images were S0, S1, S2, S3, S4, C1, C2, C3, C4, O3, O4, O5, D4, and D5. S0 represented the reference appearance, while increasing numerical suffixes represented progressively altered appearances within each trait series. Codes were used in place of diagnostic labels so participants rated the visible appearance rather than responding to terminology or explanations. The frontal intraoral format restricted attention to the anterior dentition and reduced the influence of facial attractiveness, hairstyle, and other extraoral features. The approach was adapted conceptually from the supplied parent study, which used progressively altered anterior-occlusion images to measure aesthetic tolerance [6].

Outcomes

For each image, participants answered two questions. First, they rated its attractiveness on a five-point Likert-type scale: very unattractive, unattractive, neutral, attractive, or very attractive. Second, they indicated whether they believed the displayed appearance required orthodontic treatment. The primary outcome was the distribution of attractiveness ratings for each coded image. Secondary outcomes were the derived mean attractiveness score and the proportion perceiving a need for orthodontic treatment.

For descriptive scoring, the five attractiveness categories were assigned values from 1 for very unattractive to 5 for very attractive. This transformation was used to summarize the direction and dispersion of responses, while the complete

ordinal-category distributions were retained in the tables. Likert-type responses are ordinal; therefore, means were interpreted as compact descriptive indicators rather than as proof of equal psychological distances between adjacent categories [12]. Aesthetic tolerance was considered greater when an image received a higher mean score, a larger combined proportion of attractive/very attractive responses, and a lower proportion recommending treatment.

The combined unfavourable and favourable categories were defined before interpretation to prevent selective emphasis on an individual response option. Treatment need was analysed independently from attractiveness because a participant could dislike an appearance without considering intervention necessary, or could perceive treatment need despite giving a neutral rating. Concordant movement of the two outcomes was therefore described as a pattern rather than treated as a formally tested correlation.

Data management and statistical analysis

Responses were exported from the electronic form and summarized in a structured worksheet. Categorical variables were expressed as frequency and percentage. For each image, ratings of very unattractive and unattractive were combined to describe an unfavourable response, while attractive and very attractive were combined to describe a favourable response; neutral ratings remained separate. Mean attractiveness scores and sample standard deviations were calculated from the five-category frequency distributions.

Pearson's chi-square goodness-of-fit test assessed whether responses were distributed equally across the categories of each variable. For the five-category attractiveness item, the null distribution assigned 20% of responses to each category. For the binary treatment-need item, the null distribution assigned 50% to each response. The same approach was used for gender, age group, and orthodontic-consultation distributions. Where all respondents selected treatment for D5, the binary goodness-of-fit statistic was calculated directly from the observed and expected frequencies. Statistical significance was set at $p<0.05$, and exact p values were reported when they were at least 0.001.

Counts were checked against the denominator of 78 before percentages were calculated to one decimal place. Mean scores were calculated from the weighted category frequencies, and standard deviations used the sample denominator. These calculations summarized the aggregate output without generating unsupported participant-level comparisons.

Results

Participant characteristics

The analytical sample comprised 78 respondents. The largest age group was 18-35 years (40; 51.3%), followed by those older than 50 years (18; 23.1%), those aged 36-50 years (13; 16.7%), and respondents younger than 18 years (7; 9.0%); this distribution differed significantly from equality (chi-square=31.846, $p<0.001$). There were 44 males (56.4%) and 34 females (43.6%), with no significant departure from an equal gender distribution (chi-square=1.282, $p=0.258$). Most respondents had never consulted an orthodontist (47; 60.3%), while 23 (29.5%) had consulted previously, four (5.1%) were planning treatment, and four (5.1%) were undergoing treatment (chi-square=64.051, $p<0.001$) (Table 1). Thus, approximately two-fifths of respondents had some past, planned, or current exposure to orthodontic care.

Table 1. Demographic and orthodontic-exposure characteristics of respondents (n=78)

Variable	Category	n	%	Chi-square	p value
Age	<18 years	7	9.0	31.846	<0.001*
	18-35 years	40	51.3		
	36-50 years	13	16.7		
	>50 years	18	23.1		
Gender	Male	44	56.4	1.282	0.258
	Female	34	43.6		
Orthodontic consultation	Never consulted	47	60.3	64.051	<0.001*
	Consulted previously	23	29.5		
	Planning treatment	4	5.1		
	Undergoing treatment	4	5.1		

*Chi-square goodness-of-fit test; *p<0.05.*

Attractiveness ratings

The reference image S0 obtained the highest mean attractiveness score (3.67±1.18), with 52 respondents (66.7%) rating it attractive or very attractive. Mild crowding image C1 produced a similar response (3.58±1.03; favourable rating, 62.8%), followed by S1 (3.33±1.02; 48.7%) and D4 (3.18±1.09; 37.2%). In contrast, severe crowding image C4 received the lowest score (1.92±1.15), with 59 participants (75.6%) rating it unattractive or very unattractive. D5 (2.09±1.08) and O5 (2.13±1.44) were also poorly rated, with unfavourable responses from 66.7% and 67.9%, respectively.

Within the spacing series, mean scores declined from 3.67 for S0 to 3.33 for S1, 2.96 for S2, 2.60 for S3, and 2.58 for S4. Crowding showed an overall decline from C1 (3.58) to C4 (1.92), although C3 scored slightly higher than C2. Open-bite scores decreased from 2.77 for O3 to 2.64 for O4 and 2.13 for O5, while deep-bite scores decreased from 3.18 for D4 to 2.09 for D5. Attractiveness-category distributions were statistically significant for every image, with O4 showing the weakest but still significant departure from equality (chi-square=12.256, p=0.016) (Table 2).

Table 2. Attractiveness ratings for the coded anterior-occlusion images (n=78)

Image	Trait	Mean± SD	Unattractive, n (%)	Neutral, n (%)	Attractive, n (%)	Chi-square	p value
S0	Reference/spacing	3.67±1.18	12 (15.4)	14 (17.9)	52 (66.7)	32.256	<0.001*
S1	Spacing	3.33±1.02	14 (17.9)	26 (33.3)	38 (48.7)	36.872	<0.001*
S2	Spacing	2.96±1.04	23 (29.5)	34 (43.6)	21 (26.9)	32.385	<0.001*
S3	Spacing	2.60±1.00	33 (42.3)	34 (43.6)	11 (14.1)	38.282	<0.001*
S4	Spacing	2.58±1.13	37 (47.4)	28 (35.9)	13 (16.7)	23.154	<0.001*
C1	Crowding	3.58±1.03	10 (12.8)	19 (24.4)	49 (62.8)	48.667	<0.001*
C2	Crowding	2.44±1.15	42 (53.8)	24 (30.8)	12 (15.4)	20.718	<0.001*
C3	Crowding	2.64±1.08	36 (46.2)	29 (37.2)	13 (16.7)	29.179	<0.001*
C4	Crowding	1.92±1.15	59 (75.6)	12 (15.4)	7 (9.0)	51.872	<0.001*
O3	Open bite	2.77±1.07	36 (46.2)	25 (32.1)	17 (21.8)	31.615	<0.001*
O4	Open bite	2.64±1.21	38 (48.7)	22 (28.2)	18 (23.1)	12.256	0.016*
O5	Open bite	2.13±1.44	53 (67.9)	8 (10.3)	17 (21.8)	52.385	<0.001*
D4	Deep bite	3.18±1.09	20 (25.6)	29 (37.2)	29 (37.2)	21.487	<0.001*
D5	Deep bite	2.09±1.08	52 (66.7)	19 (24.4)	7 (9.0)	34.564	<0.001*

*Ratings were scored from 1 (very unattractive) to 5 (very attractive). "Unattractive" combines very unattractive and unattractive; "Attractive" combines attractive and very attractive. Chi-square tests use the original five categories. Abbreviation: SD, standard deviation. *p<0.05.*

Perceived orthodontic treatment need

Treatment recommendations generally rose as attractiveness declined. Only 20 respondents (25.6%) recommended treatment for S0 and C1. Within the spacing series, the corresponding proportions increased to 41.0% for S1, 59.0% for S2, 80.8% for S3, and 87.2% for S4. The increase was also evident across crowding images, reaching 76.9% for C2, 79.5% for C3, and 92.3% for C4.

Open bite generated a high perceived need even at O3 (74.4%), increasing to 76.9% for O4 and 82.1% for O5. Deep bite produced the sharpest shift: responses for D4 were almost evenly divided (51.3% treatment), whereas all 78 participants recommended treatment for D5. The response was not significantly different from 50% for S1, S2, or D4, but all other images showed significant treatment-response distributions (Table 3).

Across the image set, treatment judgments broadly matched the attractiveness summaries. Images scoring above 3.00-S0, C1, S1, and D4-had the lowest treatment proportions (25.6%-51.3%), whereas C4, D5, and O5 combined the lowest mean scores with treatment recommendations of 92.3%, 100.0%, and 82.1%. Treatment need rose by 61.6 percentage points from S0 to S4 and by 66.7 points from C1 to C4. The increase from O3 to O5 was only 7.7 points because perceived need was already high at O3.

Table 3. Lay perception of orthodontic treatment need for each image (n=78)

Image	Trait	Treatment required, n (%)	Treatment not required, n (%)	Chi-square	p value
S0	Reference/spacing	20 (25.6)	58 (74.4)	18.513	<0.001*
S1	Spacing	32 (41.0)	46 (59.0)	2.513	0.113
S2	Spacing	46 (59.0)	32 (41.0)	2.513	0.113
S3	Spacing	63 (80.8)	15 (19.2)	29.538	<0.001*
S4	Spacing	68 (87.2)	10 (12.8)	43.128	<0.001*
C1	Crowding	20 (25.6)	58 (74.4)	18.513	<0.001*
C2	Crowding	60 (76.9)	18 (23.1)	22.615	<0.001*
C3	Crowding	62 (79.5)	16 (20.5)	27.128	<0.001*
C4	Crowding	72 (92.3)	6 (7.7)	55.846	<0.001*
O3	Open bite	58 (74.4)	20 (25.6)	18.513	<0.001*
O4	Open bite	60 (76.9)	18 (23.1)	22.615	<0.001*
O5	Open bite	64 (82.1)	14 (17.9)	32.051	<0.001*
D4	Deep bite	40 (51.3)	38 (48.7)	0.051	0.821
D5	Deep bite	78 (100.0)	0 (0.0)	78.000	<0.001*

*Chi-square goodness-of-fit test against an equal 50:50 distribution. *p<0.05.*

Discussion

The principal finding was a trait- and severity-dependent reduction in aesthetic tolerance. Images near the reference appearance were usually accepted, whereas the most altered crowding, open-bite, and deep-bite images received low scores and high treatment recommendations. This parallel movement of attractiveness and treatment need supports the view that laypeople use visible anterior irregularity as an immediate practical signal for seeking correction. Nevertheless, the transition was not identical across traits, indicating that aesthetic tolerance is not determined by severity coding alone.

Mild crowding was particularly well tolerated: C1 was rated almost as favourably as S0, and only one-quarter recommended treatment. Once crowding became conspicuous, treatment demand rose sharply, reaching 92.3% for C4. This agrees with evidence that laypeople are less sensitive than orthodontists to small maxillary-incisor irregularities but react when displacement crosses a visible threshold [7]. Asian laypeople have similarly shown lower aesthetic scores with severe maxillary crowding, while overbite alone exerted less influence [13]. Studies of digitally altered smiles also demonstrate that professionals recognize smaller discrepancies than lay observers [14]. Thus, mild irregularity should not automatically be assumed to create a patient-perceived need, even when it is clinically measurable.

Spacing showed a more gradual progression. Favourable ratings declined from 66.7% for S0 to 14.1% for S3, while treatment recommendations increased from 25.6% to 80.8%. Interincisor diastema has previously been identified among the least

attractive digitally modified smile features [8], although the acceptability of spacing depends on its location, magnitude, and the surrounding facial context. Frontal dental views can intensify the apparent effect of anterior occlusion because they remove facial features that otherwise dilute attention [5,15]. The present findings should therefore be interpreted as dental-view thresholds rather than complete judgments of facial attractiveness.

Vertical discrepancies produced a distinct pattern. Even O3 generated a 74.4% treatment recommendation, and this increased to 82.1% for O5. In contrast, D4 divided opinion almost equally, but D5 produced unanimous treatment demand. Boonchuay et al. found that laypeople recognized anterior open bite more readily and tolerated it less than deep bite [6]. Comparisons involving schoolchildren and orthodontists likewise show that perceived impairment varies with open-bite severity and observer group [16]. The abrupt change from D4 to D5 in the present survey suggests that deep bite may remain visually acceptable until overlap becomes sufficiently conspicuous, whereas an open anterior gap is noticed earlier.

Perceived treatment need is not equivalent to normative need. Visual thresholds describe when an appearance becomes acceptable or unacceptable to observers [17], while clinical decisions must additionally consider function, periodontal risk, stability, growth, and patient priorities. Agreement between patient and orthodontist assessments may be statistically significant yet weak, particularly when compared with the dental-health component of treatment-need indices [18]. Overbite deviations may also have limited quality-of-life impact in some populations [19], whereas crowding, spacing, and other malocclusion traits can impair psychosocial domains in others [20,21]. These differences reinforce the value of showing calibrated images during consultation and discussing why professional recommendations may not mirror appearance alone.

The broad age representation and balanced gender distribution improved the diversity of opinions. However, a single-centre convenience sample may overrepresent people engaged with dental care, and prior orthodontic contact could influence awareness. Frontal-image ratings may vary with facial context, display device, colour, or presentation order. Aggregate data supported descriptive rather than adjusted comparisons. Future multicentre studies should use validated images, standardized viewing, random order, test-retest assessment, and regression models incorporating demographic, cultural, treatment-history, and clinical variables. Psychosocial instruments may further explain different treatment motivations [22-24].

Conclusion

Laypeople showed progressively lower aesthetic tolerance as spacing, crowding, anterior open bite, and deep bite became more pronounced. Severe crowding and deep bite generated the strongest perceived treatment need, while mild spacing and crowding remained comparatively acceptable. Image-based assessment may therefore complement clinical indices by helping orthodontists identify patient-specific visual thresholds and communicate treatment need more effectively.

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Conflict of Interest

The authors declare no conflict of interest.

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