

Research Article

Evaluation of Pink Esthetic Score in Maxillary Anterior Dentition an Analytical Cross-Sectional Study

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ABSTRACT

Introduction: The anterior dentition is surrounded by soft tissue that is vital to the overall esthetic appearance of the smile, and one of the most commonly used indices to objectively assess the soft tissue framework around dental implants and in natural teeth is the Pink Esthetic Score (PES).

Objective: To assess the Pink Esthetic Score (PES) in anterior maxillary Dentition and its correlation with age, gender and ethnicity in young population of Karachi.

Methods: It was an analytical cross sectional study carried out in Dental Out Patient Department, Dow University of Health Sciences for a period of 12 months. 420 participants (210 males and 210 females) aged 18-30 years were selected through non-probability convenience sampling with strict inclusion and exclusion criteria. Standardized view photographs of the anterior teeth of the maxilla were taken with a digital single lens reflex camera equipped with a macro lens and ring flash. Images were analyzed in Adobe Photoshop and PES was calculated between canines (canine to canine) using the scale tool in Photoshop. Independent sample t test and one way ANOVA were used to analyse the data in SPSS Version 25.

Results: The most common score was 12 (43% of the sample) and 13 (39% of the sample). The scores ranged from 8 to 14, with 82% of the participants having a score of 12 to 13. There was no significant difference between the genders ($p=0.824$). The results showed that there was a significant difference between the age groups ($p=0.001$). There was no significant difference between the ethnicities ($p=0.086$).

Conclusion: In healthy natural dentition, consistently good gingival esthetics is achieved, and a realistic, local reference range is established for PES to inform treatment planning for restorative and implant based treatments in the anterior maxilla.

Keywords: Age, Gender, Ethnicity, Pink Esthetic Score (Pes), Maxillary Anterior Dentition.

INTRODUCTION

The esthetic impression is dependent upon many factors other than the shape or colour of the teeth themselves, and the periodontal tissue which frames the dentition is no exception (1). The appearance and shape of

the gums around the anterior teeth has been demonstrated to be a meaningful determinant of the attractiveness of a smile (2). Systematic reviews on smile esthetics have found that soft tissue characteristics are important and integral to any esthetic evaluation, and not

secondary (3). This recognition prompted the creation of an index which was first developed to provide an objective and reproducible method for evaluating soft tissue outcomes around single tooth implants, the Pink Esthetic Score (4). Belser et al suggested that a PES value of 60% or higher is excellent clinical acceptability (5).

The clinical implications of PES are understood when the outcomes of the implant are compared with the natural dentition, as a mismatch between the implant restoration and neighboring tooth will be immediately noticeable and reduce the esthetic outcome (6). These are partly for biological reasons, because the biotype of the soft tissue around a tooth has been proven to affect the final perception of the implant restoration (7). Similarly, studies to assess patient perception of implants in the anterior zone have also demonstrated that soft tissue appearance is a significant contributor to overall satisfaction with the outcome (8). This index has increasingly become a key measure of esthetic assessment, so its consistency has also been investigated, and it has been shown that PES scoring is reproducible between examiners with varying clinical specialties (9). When assessing the soft tissue preservation around single implants (10), PES has been the outcome measure used in comparative studies of cemented versus screw retained restorations in the anterior maxilla.

In spite of this wide application in implant dentistry, PES was developed with the aim of comparing with a natural, contralateral, reference tooth, which means the real reference is the natural dentition where every implant restoration is compared. Lanza et al. were pioneers in using the PES and WES concept directly in natural, non-restored teeth, proving that the index was useful for monitoring soft tissue stability outside of the implant environment (11). A similar study of natural anterior teeth in a Chinese sample found a mean PES of approximately thirteen, with most scores ranging between eleven and fourteen (12). Use of PES has also been made in randomized comparisons of different implant crown materials to compare esthetic outcomes with predicted natural tissue values (13). Comparatively low PES values have been reported for single tooth implants specifically placed in the esthetic zone (similar work) as compared to those reported for natural dentition (14). The index has also been shown to be useful for screening soft tissue esthetics

in healthy young adult populations, using PES and WES scoring methods (15). Studies that have investigated the relationship between the overall smileability of the anterior restorations and the patient's satisfaction have also found that overall smileability of the anterior restorations correlates well with the patient's reported satisfaction, with a low or average smile line being correlated with higher reported smile line satisfaction (16).

This collection of works clearly demonstrates the need for a reliable normative baseline derived from healthy, natural dentition and not from cohorts of implant follow-up. The existing literature on PES is mostly confined to the implant scenario and there is limited literature available on normative PES values for a healthy population without any implants, especially one as ethnically diverse as Pakistan. The other possibility is that the healthy PES value is not universal, but depends on age, gender, and ethnicity, similar to other dental esthetic parameters that have been demonstrated to vary among populations. In view of this, this study aimed at assessing the Pink Esthetic Score for maxillary anterior dentition and its correlation with age, gender and ethnicity in a young Karachi based sample. The null hypothesis states that there is no association between PES and these demographic variables; the alternate hypothesis states that there is an association.

Objectives: To assess the correlation of PES of the anterior teeth in the maxillary arch with age, gender and ethnicity.

MATERIALS AND METHODS

Study Design: An analytical cross-sectional study.

Study Setting: The study was conducted in the Dental Outpatient Departments of Dow University of Health Sciences, Karachi, on a young sample drawn from the local Karachi population.

Study Duration: Twelve months, beginning after approval of the study synopsis.

Sample Size: Sample size was determined from a comparison of two means with a power of test of ninety percent, a confidence interval of ninety-nine percent, and an Open Epi Version 3 open source calculator, for canine width (males 8.07 ± 0.57 mm, females 7.82 ± 0.65 mm). This gave a minimum number of 178 participants for each gender or 356 for both genders. The sample size was expanded to 210 males and 210 females (total sample

size of 420) to further enhance accuracy and reduce the margin of error.

Sample Technique: Non-probability sampling technique (Convenience sampling technique) was used. Participants were recruited in sequential order, as they arrived for the class, meeting the inclusion and exclusion criteria, until the required number of participants was achieved.

Inclusion Criteria: People aged 18 to 30 years were included. Participants were eligible if they had no missing anterior dentition or periodontal and gingival disease that would interfere with a healthy tissue to tooth relationship. While having interdental spacing, rotation or crowding was an orthodontic treatment need grade one, participants with such characteristics were not considered to be included, nor were those with a history of previous orthodontic treatment. Those who participated in the study had to meet each of these criteria.

Exclusion Criteria: The participants with signs of gingival modification in the maxillary anterior teeth or any dental abnormalities were excluded. Patients who showed marked tooth wear from fracture, wear, caries or restorations were excluded and patients with any obvious clinical condition of the face or dentition that would alter the esthetic appearance of the anterior region or would make esthetic evaluation difficult were also excluded.

METHODS

After signing informed consent, which included a complete description of the study and an assurance of confidentiality, 420 participants meeting the eligibility criteria were enrolled. The study was approved by the Institutional Review Board of Dow University of Health Sciences with reference number IRB-1001/DUHS/Approval/2018/52. A digital single lens reflex camera, a Canon 1300D with a 105 mm Macro Lens Sigma EX 105mf/2.8 DG and a Yongnuo YN14EX Macro ring flash were used for photos. The camera was placed at the 12 o'clock position on a tripod at a distance of

fifty centimeters from the camera to the inter-canine horizontal plane, which was marked with a measuring tape to ensure the reproducibility and eliminate barrel distortion. Camera settings were based on the Canon dental photography guideline for APS-C sensor size, with a 1:3 magnification, 1/200 seconds shutter speed, f/22 aperture, ISO sensitivity of 100, 105 mm focal length and half the power for the ring flash. The height of the chair was varied for each participant to ensure the camera captured the lower face from the tip of the nose to the bottom of the chin, with the camera grid parallel to the transverse plane and the sagittal plane parallel to the body. One photo was captured using a cheek retractor with the teeth retracted. The images were analysed in the Adobe Photoshop Version 7 software, and the Pink Esthetic Score was obtained from canine to canine by using the software's scale tool and scored according to the criteria in the study proforma for statistical analysis in SPSS Version 25 software.

RESULTS

The total number of participants in the study was 420, with 210 males and 210 females. The mean age was 22.97 years (SD = 3.10) with a minimum age of 18 years and a maximum age of 30 years; participants were categorized into 3 age groups: 18 to 21 years (n=153); 22 to 25 years (n=183); and 26 to 30 years (n=84). The participants were also grouped into five ethnic groups, Urdu speaking participants (n = 254), Punjabi (n = 59), Sindhi (n = 49), Pathan (n = 30) and Others (n = 28, including Balochi, Gujrati, Memon and Kashmiri participants).

As for the Pink Esthetic Score, the value of 12 was the most common (43% of the total sample population), followed by 13 (39% of the sample). The maximum and minimum obtained were 14 and 8, respectively, and 82% of the scores were in the range of 12 to 13, which means that most of the participants showed a healthy esthetically pleasing gingiva around the maxillary anterior teeth (Figure 4).

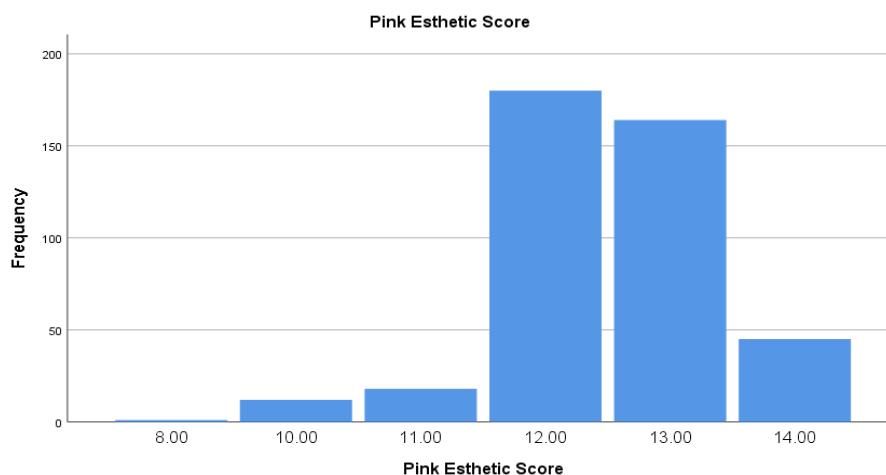


Figure 1: Pink Esthetic Score Distribution In Total Sample Population (N=420)

PES was examined by gender and both men and women had the majority of scores at 12, followed closely by a score of 13 for both men and women (n=82 each) (Figure 5). There was no statistically significant difference

between genders (p=0.824) in this sample, as determined through an independent sample t test, suggesting that both males and females in this sample had similarly healthy gingival esthetics (Table 1).

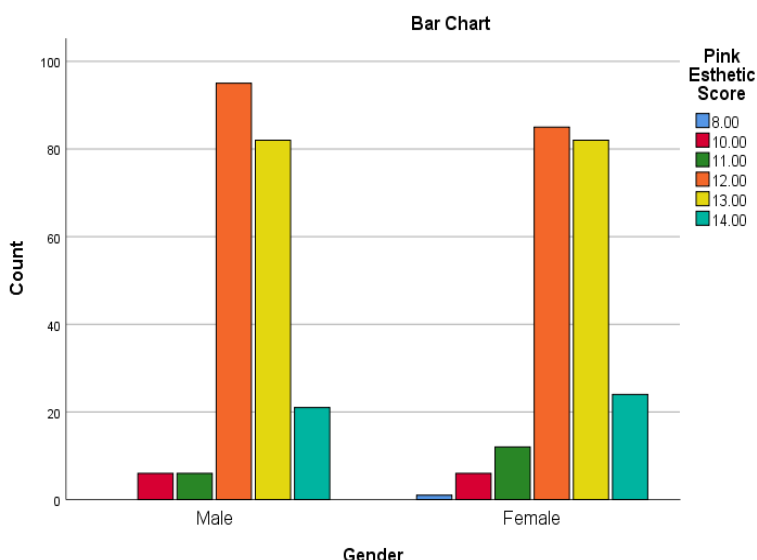


Figure 2: Pink Esthetic Score Distribution by Gender

Table 1: Independent T Test For PES With Respect To Gender

Gender	Mean $\pm$ SD	P value*
Male	12.50 $\pm$ 0.82	0.824
Female	12.48 $\pm$ 0.92	

*Independent t test; Level of Significance < 0.05.

The difference in PES was shown for different age groups (Figure 6). The 26 to 30 year group had the highest mean PES (12.80 $\pm$ 0.76), followed by the 22 to 25 year group (12.44 $\pm$ 0.77) and the 18 to 21 year group (12.37 $\pm$ 1.00). There was a significant difference between age groups overall (p=0.001) according to one way ANOVA. Post

hoc analysis with LSD values revealed that there were significant differences between the 26-30 year group and the 18-21 year group (p=0.001) and between the 26-30 year group and the 22-25 year group (p=0.002); the 18-21 year group and the 22-25 year group were not significantly different from each other (p=0.622) (p=0.467) (Table 2).

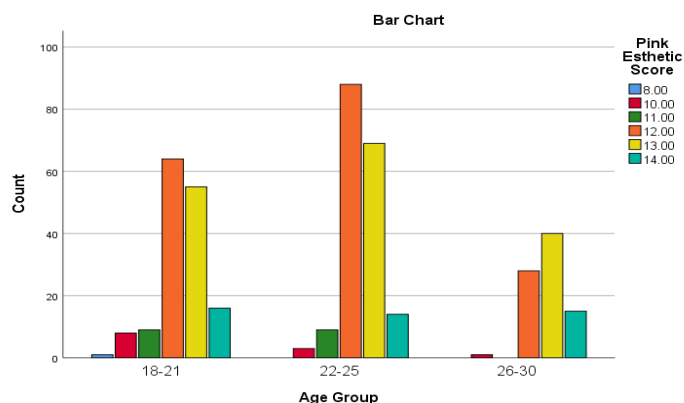


Figure 3: Pink Esthetic Score Distribution By Age Group

Table 2: One Way ANOVA For PES With Respect To Age Group

Age Group	Mean $\pm$ SD	P value*	Post Hoc Comparison
18-21	12.37 $\pm$ 1.00	0.001	26-30 vs 18-21: 0.001*
22-25	12.44 $\pm$ 0.77		26-30 vs 22-25: 0.002*
26-30	12.80 $\pm$ 0.76		22-25 vs 18-21: 0.467
Total	12.49 $\pm$ 0.87		

*Level of Significance < 0.05 (One Way ANOVA with Post Hoc LSD test).

When considering the ethnicity, the mean PES for the Pathan group was highest at 12.80 ± 0.80 , and the lowest was for the others group (12.28 ± 1.15) (Figure 7). The overall PES did not differ significantly between ethnic groups

(one way ANOVA, $p=0.086$), which means that the esthetic scores of the gums were generally similar between the different ethnic groups studied (Table 3).

Table 3: One Way ANOVA For PES With Respect To Ethnicity

Ethnicity	Mean $\pm$ SD	P value*
Pathan	12.80 $\pm$ 0.80	0.086
Punjabi	12.44 $\pm$ 0.65	
Sindhi	12.30 $\pm$ 0.98	
Urdu	12.53 $\pm$ 0.86	
Others	12.28 $\pm$ 1.15	
Total	12.49 $\pm$ 0.87	

*Level of Significance < 0.05 (One Way ANOVA).

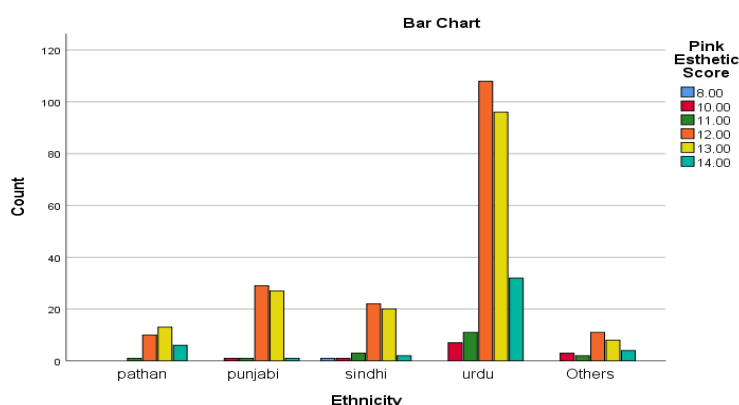


Figure 4: Pink Esthetic Score Distribution By Ethnicity

DISCUSSION

The soft tissue that surrounds a restoration has long been known to be a major factor in determining the esthetic success of anterior restorations, and the present study confirms this in the natural, unrestored dentition (1). The most common Pink Esthetic Score was 12 (43% of the sample) followed by 13 (39% of the sample). The maximum and minimum scores obtained were 14 and 8 and 82% of the total scores were in the range of 12 to 13 which shows that most of the participants of this young Karachi based sample showed a healthy and well proportioned gingival architecture around the maxillary anterior teeth. The results are similar to those of the study by Chen et al. (2018) on natural dentition in a Chinese population, which showed a mean PES of 12.92, with 96.08% of the values being within the range of 11 to 14 (3).

Compared to the literature on implants, which shows a much wider range of results, Cutrim et al. reported a PES over 10/14 after implant placement in the anterior maxilla in only 70% of their sample (3). The difference between the natural tooth findings and the outcome of implants reconstructed with soft tissue, suggests that the soft tissue surrounding implants is unlikely to ever exactly mimic natural periodontal architecture (4). However, Gallucci et al. reported significantly poorer PES results in porcelain fused to ceramic (PFC) single implant crowns as compared to all ceramic single implant crowns in a randomized clinical trial (5). Cho et al. found an even lower mean PES of 5.17 in their evaluation of maxillary single tooth implants placed specifically in the esthetic zone (6). Azevedo et al. also reported a mean score of 7.53 for their digitalized PES and WES scores among young adults (7).

This difference is clinically important and cannot be ignored! Siu showed that patients were more satisfied with implant restorations when the smile line around the implant was low or average, and not high, indicating that the visibility of the soft tissue has an influence on the perception of esthetic discrepancies (8). Luo et al. also reported that patient-reported satisfaction was directly related to the soft tissue changes around the implant in their photographic follow up evaluations (9). Fu et al. further showed that the underlying biotype of the surrounding soft tissue meaningfully influences how favorably an implant restoration is ultimately perceived (10). The

results of this study indicate that a normative range of PES values can be obtained from healthy natural teeth, which will give the dentist a more realistic reference point than post-treatment implant data for planning restorative and/or prosthetic interventions in the esthetic zone.

Originally, PES was developed to score soft tissue around a single tooth implant crown and the mean score of a small number of patients in their original cohort was 9.24, with a standard deviation of 3.8 (11). In Belser's own cohort of implants, the mean was 7.76, and they suggested that a PES $\geq$ 60% represents good clinical acceptability (12). A similar implant based value of 8.10 was reported by Buser et al. (13). These implant derived benchmarks when compared to our natural tooth findings are quite significant and further emphasize the fact that the natural dentition should be the reference standard for a true healthy pink esthetic outcome as opposed to post-surgical implant cohorts.

Methodologically, our scoring method is supported by the prior reproducibility research demonstrating that PES can be applied consistently across examiners of varying clinical specialization and thus enhances the confidence in the internal validity of our findings (14). Our results corroborate those of Lanza et al., who were the first to formally propose that the PES and WES framework could be expanded to natural, unrestored teeth, and who showed that pink tissue parameters are still a valid and reliable outcome measure in a natural context outside the context of implants (15).

The results of our analysis also indicated that there was no significant difference between the PES of the male and female participants, with the mean scores of 12.50 and 12.48 respectively. This result is similar to previous studies, which have demonstrated that gender affects the esthetic appearance of both teeth and gums in the anterior region but not necessarily in composite esthetic scoring (16). However, age was significantly associated with the PES with the 26-30 age group having a higher mean PES than the other age groups. Desai et al. provided a possible explanation for this pattern, as they have documented that there is measurable change in dynamic smile characteristics and soft tissue display with age (17). Drummond and Capelli also found that the display of incisors measured in their study was correlated with age and gender in speech

and in smiling (18), adding context to the age related variation found in our sample.

Previous population based studies also have documented ethnic variation in soft tissue display. Burgueño-Barris et al. reported that the anterior implant esthetic perception differed substantially between cross-sectional samples, highlighting the influence of population-specific factors on esthetic perception (19). In a Malaysian population, Al-Juboori et al. found that lip length was correlated with the visibility of the smile line, which might potentially interact with gingival display among ethnic groups (20). Similarly, Sepolia et al. recognized the importance of gingival visibility as a factor of an esthetic smile and pointed out that cultural variations in smiling behavior may also impact the amount of gingival visibility and therefore the score (21). This is supported by Zhang et al. who found measurable differences in the characteristics of the lip-mouth region when smiling among their sample (22). Finally, the findings of this study support the conclusion that periodontal and gingival health are still essential to the overall impression of an aesthetically pleasing smile, regardless of the dentition being natural or restored, and that locally derived normative data, such as those obtained in this study, are more accurate than benchmarks based on implants alone (23).

CONCLUSION

This study set a locally derived normative range of Pink Esthetic Score for a young population of the city of Karachi in the present study for a healthy and natural maxillary anterior dentition. The PES value of 12 was the most frequent score reported by 43% of participants, followed by a score of 13 by 39% with 82% of all scores within this narrow range of 12 to 13. The results of this study support the following: When strict inclusion criteria are applied, healthy natural dentition exhibits consistently good gingival esthetics, and this natural standard is superior to the PES values generally reported in implant based cohorts. Gender did not significantly affect PES, suggesting that there is no meaningful effect of gender on gingival esthetic outcomes in natural teeth. However, age was a significant factor with the top scores being recorded by participants aged 26 to 30 years. Ethnicity was not significantly associated with PES, indicating that PES is quite similar across all of the ethnic groups. These results serve as a realistic and population-specific reference for

gingival esthetics that can better guide treatment planning for anterior maxilla restorative, prosthetics, and implant based rehabilitation, where the desired outcome is to achieve a pink esthetic outcome naturally achieved in healthy untreated dentition.

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