Research Article ISSN 2639-9490

Oral Health & Dental Science

Tweed Facial Triangle Norms Among Sudanese

Hayder Abdalla Hashim[1]*, Fatima AL-Suwaidi[2], Mohamed Hayder Hashim Mohamed[3], Dalia K. Taher[4], and Najat AL Sayed[5]

[1]*Professor and senior consultant, Hamad Medical Corporation Hamad dental Centre, Orthodontic division, Qatar.*

[2]*Cardiff University /Biomedical Science, UK.*

[3]*Orthodontist, Private Practice, Qatar.*

[4]*Orthodontist. Private Practice, Canada.*

[5]*Associate professor and head division of orthodontics, Hamad Medical Corporation, Rumaila Hospital, Hamad dental Centre, Qatar.*

***Correspondence:**

Hayder Abdalla Hashim, Professor and senior consultant, Hamad Medical Corporation Hamad dental Centre, Orthodontic division, Qatar, E-mail: hahashim78@yahoo.com.

Received: 03 Jul 2024; **Accepted:** 17 Aug 2024; **Published:** 25 Aug 2024

Citation: Hashim HA, AL-Suwaidi F Mohamed MHH, et al. Tweed Facial Triangle Norms Among Sudanese . Oral Health Dental Sci. 2024; 8(4); 1-6.

ABSTRACT

Aims: *The objectives of the present study were to establish Tweed facial triangle norms in Sudanese and to compare the result with Tweed norms and previous reported results in different racial groups.*

Material and Method: *The sample consisted of 103 lateral cephalometric radiographic radiographs with age range 18 to 25 years old.*

Results: *The result of the present study showed that the mean values of FMA 25.39º +/- 6.8º FMIA 59.89º +/- 9.08º angles and IMAP 94.71º +/- 9.67º. The result in Sudanese revealed significantly higher mean values compared to Tweed norms except for FMA angle. The comparison with other races shows statistically significant differences when compared to Sudanese result.*

Conclusion: *Tweed's emphasis on the importance of cephalometric analysis highlights the need for precise measurement in orthodontic diagnosis and treatment planning. The study established mean values for Tweed's Facial Triangle for the Sudanese, which is valuable, as it addresses the variability in facial structure across different ethnic groups, which can lead to more accurate and effective orthodontic treatment outcomes.*

Keywords

Sudanese, Tweed Facial Triangle norms, Cephalometric analysis, Orthodontics, Lower incisors.

Introduction

Cephalometric radiography is primarily used to describe facial skeletal morphology and growth, predict future growth, plan treatments, and evaluate treatment outcomes. This involves digitally or manually determining skeletal and dental relationships using specific points for linear and angular measurements. These measurements can then be compared to reference values from different racial groups. Various analyses have shown differences across racial and ethnic groups [1-8].

Tweed developed his own analysis, known as the Tweed Facial Triangle, to establish a meaningful relationship between the mandible and the position of the lower incisors. His analysis was based on four cases that he believed had aesthetically pleasing facial features. The Tweed Triangle consists of three components: the Frankfort horizontal plane, which runs between the Prion and Orbitale points (P-Or), the mandibular plane, which connects the Menton to the Gonion (Men-Go), and the Inciso-mandibular

plane, which is a line drawn through the apex and incisal edge of the mandibular central incisor, extending to intersect the Frankfort horizontal and mandibular planes [3]. Thus, using these three planes he introduced the diagnostic triangle forming the following angles; Frankfort mandibular incisal angle (FMIA), Frankfort mandibular plane angle (FMA) and third and most important angle is the Incisal mandibular plane angle (IMPA) [3]. Using these three planes, Tweed introduced the diagnostic triangle, which forms the following angles: the Frankfort Mandibular Incisal Angle (FMIA), the Frankfort Mandibular Plane Angle (FMA), and the most important angle, the Incisal Mandibular Plane Angle (IMPA) [3].

Tweed conducted several investigations comparing his measurements to those of Downs. In his studies, which included four treated cases, 37 sample cases, and 95 sample cases, Tweed found that the FMIA (Frankfort Mandibular Incisal Angle) was typically around 65°, with a range of 64.5° to 66°. The FMA (Frankfort Mandibular Plane Angle) averaged 25°, with a range of 20° to 30°. The normal variation of the inclination of the mandibular incisor to the mandibular plane, the IMPA (Incisal Mandibular Plane Angle), ranged from 85° to 95°, with 90° being considered the norm. Tweed concluded that these angles were workable figures, leading to more ideally proportioned facial aesthetics and stable results.

Tweed also suggested that the norms used by Downs, particularly the normal inclination of the mandibular central incisors (91.4°), warranted further investigation [1,3]. Tweed emphasized the significance of the FMIA angle of 65° in treatment planning, particularly when deciding between extraction and non-extraction approaches. He advised that in cases with fair facial aesthetics and an FMIA angle less than 57° or 58°, practitioners should avoid rushing into extracting all four first premolars to achieve an FMIA angle of 65°. Conversely, in cases with poor facial aesthetics, he recommended extracting all four first premolars to achieve an FMIA angle of 65° or greater. Tweed concluded that the suggested norms might not be as accurate as previously thought [3].

Tweed also proposed that the lower incisors should be vertically positioned on the basal bone, with an IMPA of 90°. He emphasized that achieving the correct inclination of the lower mandibular incisors requires the use of a cephalogram, as visual estimation alone is not as accurate as measurements from a lateral skull radiograph [3]. Further, Tweed reported that the standard range of 22-28 degrees indicates a normal skeletal growth pattern. An FMA (Frankfort Mandibular Plane Angle) above this range suggests excessive vertical growth, while an FMA below it indicates deficient vertical growth. A key measurement is the Incisal Mandibular Plane Angle (IMPA), which reflects the angle between the lower incisors and the mandibular plane. The standard IMPA of 88 degrees indicates an optimal position of the lower incisors, balancing the lower facial profile. When FMA is above normal, the incisors may need to be further up righted, while a lower FMA may require keeping or slightly labializing the incisors. Generally, labial inclination should not exceed 94 degrees to maintain tissue health and stability [9,10].

Aims

A review of the literature reveals that there is no recorded data on Tweed's facial triangle norms for the Sudanese population. Therefore, this study aims to establish Tweed's facial triangle norms for The Sudanese and compare the results with Tweed's original norms and those from other published reports across different racial and ethnic groups.

Material and Method

Subjects

The sample consisted of 103 lateral cephalometric radiographs of Sudanese patients aged 18-25 years. The selection criteria included having, minimal or no crowding or spacing, no previous orthodontic treatment, no facial deformities, and high-quality radiographs. Consent forms and ethical approval were obtained. A well-trained technician took the radiographs at a distance of 5 feet, with patients looking straight into a mirror. One operator (SS) digitally traced all lateral cephalographs using the WebCeph application.

Method

The cephalograms were traced digitally. The following three angles forming Tweed's facial triangle were drawn and measured to the nearest 0.5°: the Frankfort Mandibular Plane Angle (FMA), the Frankfort Mandibular Incisal Angle (FMIA), and the Incisor-mandibular Plane Angle (IMPA) (Figure 1).

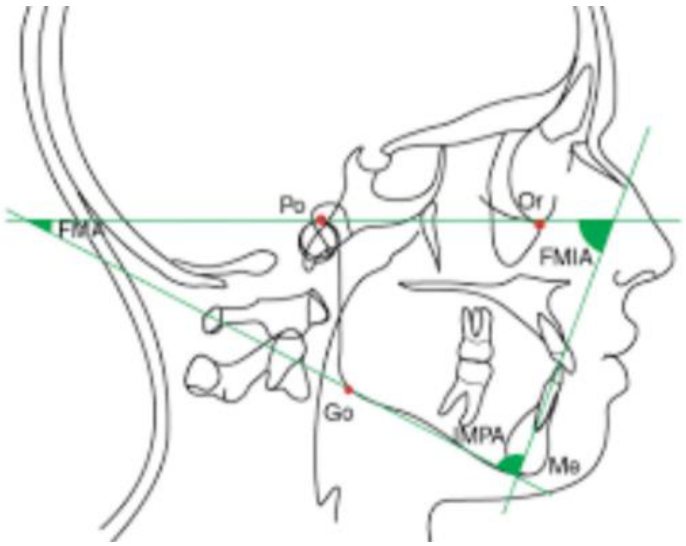

Figure 1: The Tweed facial triangle: FMIA, FMA AND IMPA angles.

Statistical Analysis

The data was analyzed using Microsoft Excel. Descriptive statistics, including mean and standard deviation, were calculated. For analytical statistics, Student's t-test was used to determine whether there were significant differences between the Sudanese mean values of Tweed's facial angles and Tweed's original norms, as well as to compare the results of this study with those from previously published reports on different racial and ethnic groups. The level of significance was set at $p< 0.05$

Results

The error of the method was assessed by double measurements taken at least one-week interval on five randomly selected cephalograms. The t-test results indicated that there were no statistically significant differences between the two sets of readings.

Table 1: Mean and standard deviation values of Tweed triangle in Sudanese.

Variable	Mean	SD	N
FMIA	59.89	9.1	103
FMA	25.39	6.8	103
IMPA	94.71	9.7	103

Table 1 All three angular measurements in the combined sample indicated that the Frankfort-mandibular incisal angle (FMIA), Frankfort Mandibular angle, (FMA) and Incisor-mandibular plane angle were found to be 59.89°, 25.39°, and 94.71°; respectively.

Table 2: Comparison between present study result and Tweed triangle norms.

Variable	Sudanese result			Tweed Norms			Statistics result	
	Mean	SD	N	Mean	SD	N	P-value	Sig level
FIMA	59.89	9.1	103	68.20	3.0	95	0.0001	Ext. Sig
FMA	25.39	6.8	103	24.57	3.0	95	0.2806	N.S
IMPA	94.71	9.7	103	86.93	3.0	95	0.0001	Ext. Sig

P> 0.05 NS: Not significant. P<0.0001 Ext. Sig: Extremely significant.

Table 2 indicated extremely statistically significant differences of both FMIA and IMPA angles of Tweed's facial triangle norms advocated by Tweed when compared to Sudanese FMIA and IMPA mean values. No significant was found of angle FMA between both.

Table 3: Comparison of Tweed Triangle mean values between Sudanese and Iraqi.

Variable	Sudanese			Iraqi			Statistics result	
	Mean	SD	N	Mean	SD	N	P-value	Sig level
FIMA	59.89	9.1	103	58.73	6.2	95	0.2998	NS
FMA	25.39	6.8	103	24.09	5.0	95	0.1296	NS
IMPA	94.71	9.7	103	97.17	5.9	95	0.0341	Sig

P> 0.05 NS: Not significant. P<0.05, Sig: Significant.

Table 3 Exhibited statistically significant differences at 5% level in IMPA angle only between Sudanese and Iraqi. No Significant difference was noted in FMIA and FMA angles (p> 0.05).

Table 4: Comparison of Tweed Triangle values between Sudanese and Qatari.

Variable	Sudanese			Qatari			Statistics result	
	Mean	SD	N	Mean	SD	N	P-value	Sig level
FIMA	59.89	9.1	103	52.00	8.8	43	0.0001	Ext. Sig
FMA	25.39	6.8	103	33.50	6.2	43	0.0001	Ext. Sig
IMPA	94.71	9.7	103	94.5 6	6.8	43	0.9266	NS

P> 0.05 NS: Not significant. P< 0.0001 Ext. Sig: Extremely significant

Table 4 showed extremely statistically significant differences in FMIA and FMA angles between Sudanese and Qatari. No Significant difference was observed in IMPA angle

Table 5: Comparison of Tweed triangle mean values between Sudanese and Black Brazilian [18].

Variable	Sudanese			Black Brazilian			Statistics result	
	Mean	SD	N	Mean	SD	N	P-value	Sig level
FIMA	59.89	9.1	103	50.91	8.4	37	0.0001	Ext. Sig
FMA	25.39	6.8	103	20.13	6.9	37	0.0001	Ext. Sig
IMPA	94.71	9.7	103	99.88	4.4	37	0.0129	Sig

N: Sample size, P< 0.05: Sig: Significant P< 0.0001 Ext. Sig: Extremely significant.

Table 5 Demonstrated extremely statistically significant differences in FMIA and FMA angles between Sudanese and Black Brazilian. Significant difference at 5% level was observed in IMPA angle**.**

Table 6: Comparison of Tweed triangle mean values between Sudanese and African Nigerian.

Variable	Sudanese			Nigerian			Statistics result	
	Mean	SD	N	Mean	SD	N	P-value	Sig level
FIMA	59.89	9.1	103	54.08	5.1	84	0.0001	Ext. Sig
FMA	25.39	6.8	103	23.26	4.8	84	0.0165	Sig
IMPA	94.71	9.7	103	103.47	6.3	84	0.0001	Ext. Sig

N: Sample size, P< 0.05: Sig: Significant P< 0.0001 Ext. Sig: Extremely significant.

Table 6 Demonstrated extremely statistically significant differences in FMIA and IMPA angles between Sudanese and Nigerians Significant difference at 5% level was observed in FMA angle.

Discussion

Tweed emphasized that the main objectives of orthodontic treatment are to achieve balance and harmony in facial lines, ensure the stability of the dentition after treatment, maintain healthy oral tissues, and establish an efficient chewing mechanism. With these goals in mind, research has focused on the soft-tissue changes that occur in relation to tooth movement [11].

Numerous studies have investigated differences in standard cephalometric measurements among various racial and ethnic groups. Most of this research compares Caucasians with non-Caucasian groups, such as Japanese, Chinese, Filipinos (Oriental), Africans (Black), African Americans, and Arabs. The findings generally indicate that Black and Oriental groups exhibit the most protrusive dentition, whereas Caucasians typically have the most retrusive dentition. This finding was noted in the result of the current study.

Tweed's Facial Triangle is a diagnostic and treatment planning method in orthodontics. Tweed suggested that maintaining specific values for the FMA, FMIA, and IMPA angles would improve facial aesthetics and lead to more stable results. He particularly emphasized that the lower incisors should be inclined at 90º ± 5º relative to the basal bone for optimal outcomes [9,12]. Thus, accurately assessing the IMPA value, keeping it within 94 degrees, is crucial for effective orthodontic treatment planning. Several researchers have investigated the ideal positioning of the lower incisors relative to the basal bone. Hasund and Böe [13] developed

a multiple regression equation to determine this position, utilizing floating norms based on the key variables ANB, ML-NL, and the N angle. Mills [14] proposed that the natural positioning of the lower incisors is the most stable, as it aligns with the neutral zone. On the other hand, William [15] contended that no single method is ideal. He recommended using Ricketts' A-Po line to guide the direction of movement, while also considering Mills' cautious approach to maintain a balance between aesthetics and stability. William also stressed the importance of further research to better understand the practical applications of these methods. Moreover, Ciavarella et al. [16] investigated the potential link between changes in lower incisor position after orthodontic treatment and gingival recession. Their findings indicated that patients with excessively proclined lower incisors (>95°) were more likely to develop gingival recession, unlike those with normal incisor inclination. However, despite the increased proclination of lower incisors (94.71° ± 9.67°) in the current study, similar results were not observed.

Further, the findings of the current study did not align with Tweed's recommendations, as the mean values for FMIA (59.89° ± 9.1°) and IMPA (94.71° ± 9.7°) were significantly higher than Tweed's facial triangle norms, with the exception of the FMA angle (25.39° ± 6.8°). These results indicated notably proclined lower incisors and a decreased FMIA angle. In contrast, the FMA angle showed no significant difference. Furthermore, the present study revealed extremely significant differences in FMIA and FMA facial angles between the Black Brazilian [17] and Sudanese samples, with the Sudanese group displaying higher mean values for both FMA and FMIA. In contrast, the Black Brazilian group exhibited significantly more proclined lower incisors ($p<0.000$). When comparing the results with the Nigerian population [18] the study found extremely significant differences in the FMIA and IMPA angles. A significant difference at the 5% level was also observed in the FMA angle. When comparing the results of the present study with those obtained from the Qatari population [19], the findings indicated that the Sudanese group showed an extremely significant difference in the FMIA angle, while the Qatari group exhibited an extremely significant difference in the FMA angle. However, no significant difference was observed in the IMPA angle ($P>0.05$). Additionally, the comparison with the Iraqi population [20] revealed a significant difference only in the IMPA angle ($P<0.05$), while no significant differences were found in the FMIA and FMA angles ($P>0.5$). The differences noted between the Sudanese population and the above mentioned studies could be attributed to the difference in racial and ethnicity as well as the methodology of obtaining the cephalometric data.

Several studies have consistently reported an absence of sexual dimorphism in facial measurements, suggesting that male and female facial structures may not differ significantly in certain populations [17,21,22]. For instance, Bhattarai et al. [21] found no significant differences between male and female facial measurements in Nepalese individuals, while Kuramae et al. [17] in black Brazilian and Hasan et al. [22] observed similar patterns in Bangladeshis. These findings suggest that in certain populations, the influence of sex on craniofacial dimensions may be minimal, which has implications for both clinical practice and research. However, sexual dimorphism was not investigated in the current study among Sudanese population. Hence, future studies can be carried out with larger sample size to know and confirm the values and differences between both genders that could help in establishing accurate orthodontic diagnosis and treatment planning.

It is noteworthy to mention that these differences in cephalometric norms among different ethnic and racial groups were reported for each specific group. Thus, care should be taken not to apply those specific norms to another different racial group. Such recommendation was stated by several investigators [2,3,9,12]. Therefore, using specific norms for specific race or ethnic group will help in providing more accurate diagnosis and treatment planning with the aid of cephalogram [3].

Conclusion

Tweed's Facial Triangle mean values were established for Sudanese population. However, the current study results show two statistically significant differences compared to Tweed's facial norms values. As a result, Tweed facial triangle norms should be used only as a guide and not as an absolute value. Hence, using specific norms for specific race or ethnic group will help in providing more accurate diagnosis and treatment planning.

References

1. Downs W. Variations in Facial Relationship: Their Significance In Treatment and Prognosis. Am J Orthod. 1948; 34: 812-840.
2. Steiner CC. Cephalometric for you and me quot. Am J Orthod. 1953; 39: 729-755.
3. Tweed CH. The Frankfort-Mandibular Incisor Angle (FMIA) In Orthodontic Diagnosis, Treatment Planning and Prognosis. Angle Orthod. 1954; 24: 121-169.
4. Ricketts RM. Cephalometric Analysis and Synthesis. Angle Orthod. 1961; 67: 125-138.
5. Jacobson A. The Wits appraisal of jaw disharmony. Am J Orthod. 1975; 67: 125-138.
6. McNamara JA, A method of cephalometric evaluation. Am J Orthod. 1984; 86: 449-469.
7. Chan GK. A cephalometric appraisal of the Chinese (Cantonese). Am J Orthod. 1972; 61: 279-285.
8. Drummond RA. A determination of cephalometric norms for the Negro race. Am J Orthod. 1968; 54: 670-682.
9. Charles H Tweed. The diagnostic facial triangle in the control of treatment objectives. Am J Orthod. 1969; 55: 651-667.
10. Charles H Tweed. The Frankfort-mandibular plane angle in Orthodontic Diagnosis, Classification, Treatment. Am J Orthod. 1946; 32:175-230.
11. Tweed CH. Evolutionary trends in orthodontics, past, present, and future. Am J Orthod. 1953; 39: 81-108.

12. Tweed CH. Was the development of the diagnostic facial triangle as an accurate analysis based on fact or fancy? Am J Orthod. 1962; 48: 823-840.
13. Hasund A, Böe OE. Angle Floating Norms as Guidance for the Position of the Lower Incisors. Angle Orthod. 1980; 50: 165-168.
14. Mills JRE. Principles and Practice of Orthodontics. Churchill Livingstone, Edinburgh. 1982.
15. Williams P. Lower Incisor Position in Treatment Planning. Bri J Orthod. 1986; 13: 33-41.
16. Domenico Ciavarella, Michele Tepedino, Crescenzio Gallo, et al. Post-orthodontic position of lower incisors and gingival recession: A retrospective study. J Clin Exp Dent. 2017; 9: 1425-1430.
17. Mayury Kuramae, Maria Beatriz Borges de Araújo Magnani, Darcy Flávio Nouer, et al. Analysis of Tweed's Facial Triangle in Black Brazilian youngsters with normal occlusion. Braz J Oral Sci. 2004; 3: 401-403.
18. Olawande Adebisi Ajisafe, Babatunde Ogunbiyi Ogunbanjo, Kikelomo Olubukola Adegbite, et al. Evaluation of Tweed's Facial Triangle among Students in Lagos, Nigeria. Orthodontic J Nepal. 2020; 10: 31-39.
19. Hayder Abdalla Hashim, Najat AL Sayed, Aya AL Qaisi, et al. Comparison of Tweed Facial Triangle Norms Among Different Ethnic Groups. EJMED. 2020; 4: 1-4.
20. Mohammed Nahidh, Yassir A Yassir, Noor FK Al Khawaja. Wits appraisal and Tweed triangle for a sample of Iraqi adults. J Bagh Coll Dentistry. 2011; 23: 134-140.
21. Bhattarai P, Shrestha RM. Tweeds analysis of Nepalese people. Nepal Med Coll J. 2011; 13: 103-106.
22. Hasan Md Rizvi, Zakir Hossain Md. Cephalometric Profile of Bangladeshis: Tweeds Analysis. APOS. 2017; 7: 130-134.