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Is the ANB Norm in TAO Board Examination Appropriate? Meta-analysis of Taiwanese Cephalometric Norms

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Abstract

Purpose: According to clinical experience, the ANB angle (A point, nasion, B point) norm value of Taiwan Association of Orthodontists (TAO) board examination seems to be larger than the Taiwanese population. Therefore, this study aimed to integrate studies of Taiwanese cephalometric norms by a meta-analysis.

Patients and Methods: Studies were searched from electronic database of PubMed, National Digital Library of Theses and Dissertations in Taiwan, and physical libraries. Ten measurement values were collected. According to age and gender, all samples were divided into three groups. A meta-analysis of the mean and standard deviation values in all groups was performed.

Results: The search across the databases identified 253 studies, and 10 studies met the inclusion criteria. Most of the results were similar to TAO norms. However, the ANB of the TAO norm was larger than the results of the three groups. Specifically, in group A (aged 10–30 years), males had ANB of 1.56°–5.04°, while females had 1.15°–4.55°. In group B (aged 10–14 years), males had 1.53°–5.11°, while females had 1.3°–4.76°. In group C (aged 15–30 years), males had 1.4–5.02°, while females had 0.7°–3.8°.
Conclusion: This study integrated the norms of previous studies in Taiwanese population. The results revealed that the ANB norm of TAO was larger. This study provides a new reference for the establishment of normal values in the future.

Keywords

Taiwan; Cephalometric Norms; ANB

REVIEW ARTICLE

Is the ANB Norm in TAO Board Examination Appropriate? Meta-analysis of Taiwanese Cephalometric Norms

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ABSTRACT

Purpose: **According to clinical experience, the ANB angle (A point, nasion, B point) norm value of TAO board examination seems to be larger than the Taiwanese population. Therefore, this study aimed to integrate studies of Taiwanese cephalometric norms by a meta-analysis.**

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Conclusion: **This study integrated the norms of previous studies in Taiwanese population. The results revealed that the ANB norm of TAO was larger. This study provides a new reference for the establishment of normal values in the future.**
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Keywords: Taiwan; Cephalometric norms; ANB

INTRODUCTION

The introduction of cephalometric radiography in 1934 by Hofrath in Germany and in 1931 by Broadbent[1] in the United States provided both a research and a clinical tool for the study of malocclusion and underlying skeletal disproportions. The original purpose of cephalometry was to investigate the growth patterns in the craniofacial complex. Thereafter, cephalometric radiographs could be used to evaluate dentofacial proportions and clarify the anatomical basis for a malocclusion.[2] Various analysis methods have been devised, such as those by Downs,[3−5] Steiner,[6] Tweed,[7,8] McNamara,[9] Harvold,[10] and Wits.[11]

However, the diversity of skull morphologies in different ethnic groups should be considered. Therefore, for the appropriate application of any cephalometric analysis, norms used should be derived from populations similar to patients with orthodontic problems in terms of ethnicity, gender, and age.[12]

Many cephalometric studies of Chinese populations have been conducted worldwide including those by Wu et al., in 2007[13] and Cook and Wei in 1989.[12] A compilation of Chinese norms was also published by Moate and Darendeliler in 2002.[14] However, with the wide geographic distributions of

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the Chinese populations, there might be some morphological changes within this ethnic group.[15]

Taiwan is made up of various ethnic groups and indigenous people. In the 17th century, Han people including Hokkien and Hakka migrated to Taiwan.[16] Mainlanders also immigrated in the postwar period. Until nowadays, new Taiwan residents are immigrants. Therefore, Taiwan has a wide range of ethnicities. Hokkien made up the majority, accounting for approximately 70%, which means that the demographic composition in Taiwan is different from that of China.[16]

Until now, studies of Taiwanese norms are usually limited to a certain age and have not been integrated.[17−26] The ANB norm values of TAO board examination,[27] which is 4.1°−5.7° in men and 3.2°−5° in women, appear larger, i.e., beyond the clinical experiences in Taiwanese populations.

The aim of this study was to gather all studies related to Taiwanese cephalometric norms and provide stronger statistical support for Taiwanese norms by a meta-analysis.

PATIENTS AND METHODS

The research was restricted to articles registered from the date of inception of PubMed to August 2020. No limitation on the year of publication was imposed. To ensure that the research would encompass all studies related to the topic, the keywords were used as follows: cephalometric AND orthodontic AND norms AND (Taiwan OR Chinese OR Asia). Moreover, by manual search, old journal articles or related studies that could not be found on electronic databases were searched from the National Digital Library of Theses and Dissertations in Taiwan and physical libraries.

Research papers were selected based on the following criteria: (1) Taiwanese population, (2) Angle Class I occlusion and no apparent crowding and spacing, (3) having an acceptable appearance and no obvious facial asymmetry, and (4) have never accepted orthodontic treatment previously.

Partial norms could be affected by growth patterns.[2] Therefore, all samples were grouped by age and were divided into three groups: group A (aged 10−30 years), group B (aged 10−14 years), and group C (aged 15−30 years). The age boundary depended on whether the original data were recorded or not. According to the currently used TAO norms, 10 measurement items including SNA, SNB, ANB, SN-MP, U1-NA (mm), U1-SN, L1-NB (mm), L1-MP, U lip-Eline, and L lip-Eline were collected. The mean and standard deviation values of these 10 items for male and female participants in each study were combined.

The meta-analysis was completed with Comprehensive Meta-Analysis Software Version 3.0. Statistical differences between the results of the available studies and currently used TAO norms could not be evaluated because of the unavailability of information about the sample size, sample age, and standard deviation in the original TAO norms data.

RESULTS

Through electronic literature search, 233 articles were found from PubMed. From the manual search, 20 studies were identified from the National Digital Library of Theses and Dissertations in Taiwan and in physical libraries. After screening the title and abstract, non-Taiwanese articles and studies not related to the present study were excluded (Figure 1). Finally, 10 studies, whose full texts were assessed for eligibility and had met the inclusion criteria, were included in the analysis. The titles of these 10 studies are shown in Table 1.

The overall 56 results of group A, B, and C are shown in Table 2. The mean value range of 10 items of TAO is also presented in Table 2. TAO only showed the mean range of each item originally. Thus, in the present study, the midpoint of each range was presented for easier comparison. By contrast, the definition of the mandibular plane in TAO was GoMe, but it was GoGn in other studies. Therefore, the SN-MP item in the present study could not be compared with TAO norm.

Adequate statistical comparison with TAO norms was not possible because of the unavailability of the information about the sample size, sample age, and standard deviation in the original TAO norms data. Therefore, there were only qualitative descriptions and direct comparisons of the results.

In the anteroposterior dimension, compared with TAO norms, results were found to have decreased facial convexity (the ANB of group A was 3.30° ± 1.74° in males and 2.85° ± 1.7° in females), which was probably due to the larger SNB values when compared with TAO norm. The U lip and L lip to E-line were both smaller than TAO norms, which was consistent with the result presenting less facial convexity. The upper and lower incisors' degrees of proclination and protrusion were similar with TAO norms. Vertically, the inclination of the mandibular plane could not be compared with that of TAO because of the different definitions of the mandibular plane.

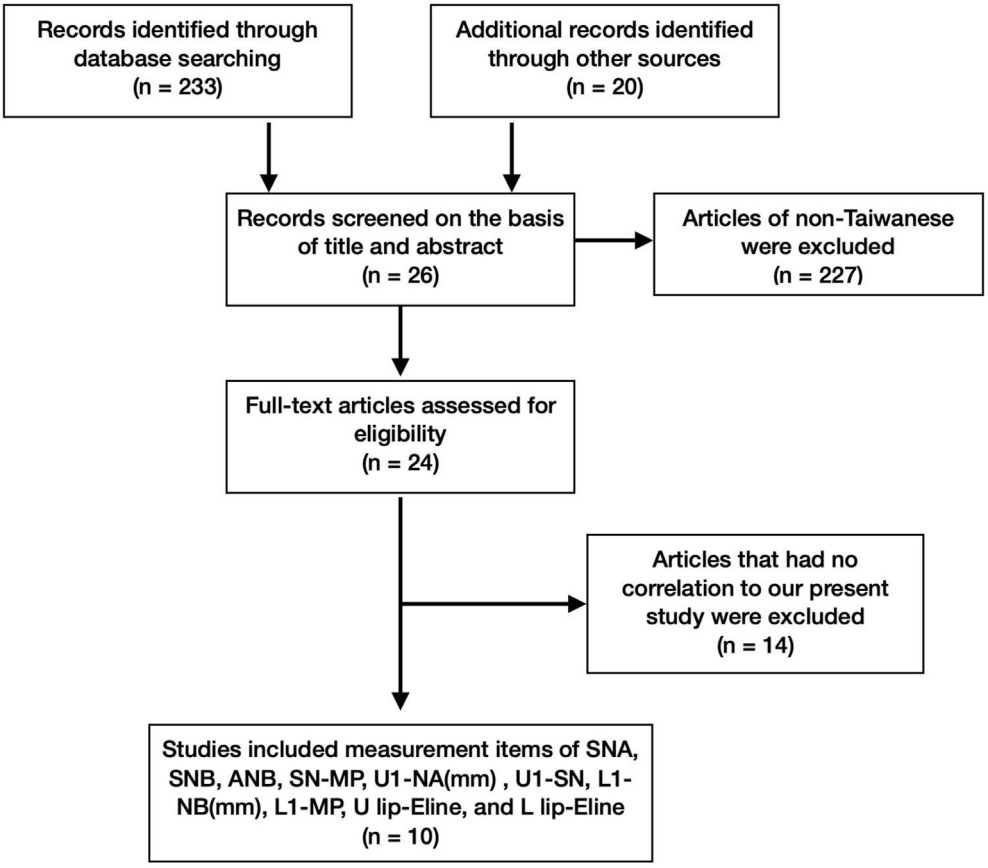

Figure 1. Flow chart of the selection of relevant studies.

In the results of SNA, SNB, and ANB shown in Tables 2–5, each mean value in groups A, B, and C demonstrated a significant difference ($p < 0.05$) compared with 10 studies. The norm of SNA and SNB in group C were both larger than that of group B, while the norm of ANB in group B was larger than that in group C. The results of SNB were all larger than TAO norm in each group, and the values of ANB were all smaller than TAO norm in each group. The difference between the results of SNA and TAO norm was not obvious.

DISCUSSION

Identifying the normal features of a specific race or ethnic group should be the basis for proper diagnosis and treatment planning of patients with orthodontic disorders.[12] When conducting this study, common cephalometric measurements were selected according to TAO[27] that represented different hard and soft features of normal Taiwan individuals. The meta-analysis greatly increases the overall sample size by combining data from individual studies, increasing the statistical power of the analysis and the precision at assessing the normal values of the subjects.

Among the 10 papers, only three had calculated the mean values by dividing samples into subgroups by age; the other seven papers pooled all samples together. In this study, all samples were divided into three groups. Groups A, B, and C included individuals aged 10–30 years, school children aged 10–14 years, and adolescents and adults aged 15–30 years, respectively. In different groups, certain values would increase or decrease during aging. Although the boys' growth spurt age started later than girls',[2] in this study, we could only grouped two genders into the same age range due to the limitation of the original data.

Because of the different definition of mandibular plane, SN-MP, and L1-MP values in group A, B, and C could not be compared with TAO norms. The related values of upper and lower incisors were similar with TAO norms. In the anteroposterior dimension, the SNA and SNB values were larger in group C than in group B, showing that the maxilla and mandible are still growing during aging. Moreover, values of both items were larger than

Table 1. 10 studies that met the inclusion criteria.

Authors of studies	Titles of the studies identified	Sample size and age
(1) Guo et al., 1971	Cephalometric standards of Steiner analysis established on Chinese children.	Age: 11−13 years old N: male = 50, female = 46
(2) Wang et al., 1983	The norms of Steiner cephalometric analysis in Chinese children.	Age: 12 years old N: male = 34, female = 35
(3) Lin et al., 1985[a]	Steiner cephalometric analysis of 10−15 year old Chinese.	(3) Age: 10 years old N: male = 30, female = 30 (3a) Age: 11 years old N: male = 30, female = 30 (3b) Age: 12 years old N: male = 30, female = 30 (3c) Age: 13 years old N: male = 30, female = 30 (3d) Age: 14 years old N: male = 30, female = 30 (3e) Age: 15 years old N: male = 30, female = 30
(4) Liu et al., 1986	The study of craniofacial structure−the norms of Steiner analysis in Chinese adults.	Age: 20−30 years old N: male = 30, female = 30
(5) Lin et al., 1985[b]	The study of craniofacial structure −the norms of Bjork analysis in Chinese young adults.	(5) Age: 13−15 years old N: male = 90, female = 90 (5a) Age: 13 years old N: male = 30, female = 30 (5b) Age: 14 years old N: male = 30, female = 30 (5c) Age: 15 years old N: male = 30, female = 30
(6) Hong et al., 1965	Cephalometric standards established by use of the lattice and angular-linear methods for Chinese children of average orthodontic age with excellent occlusion.	Age: 11.8 years old in average N: male = 51, female = 56
(7) Chang et al., 1981	A study of soft tissue facial profile of Chinese adult.	Age: 18−29 years old N: male = 33, female = 33
(8) Fan et al., 1995[c]	A study of radiographic cephalometric analysis and Taiwanese standards.	(8) Age: 9−11 years old N: male = 118, female = 109 (8a) Age: 12−14 years old N: male = 127, female = 146 (8b) Age: 15−18 years old N: male = 62, female = 55
(9) Chen et al., 1977	Roentgenocephalometric studies on normal occlusion and malocclusion among Chinese. I. Cranio-dental-facial structural variations associated with mandibular inclination in normal bites.	Age: 11.1 years old in average N: male = 27, female = 0
(10) Chao et al., 1988	The study of craniofacial structure −the norms of soft tissue facial profile analysis in Chinese adults.	Age: 20−30 years old N: male = 30, female = 30

[a] In the study 3, there are 6 subgroups according to age (10 years old in group 3; 11 years old in group 3a; 12 years old in group 3b; 13 years old in 3c; 14 years old in 3d; 15 years old in 3e.).
[b] In the study 5, there are 4 subgroups according to age (13−15 years old in group 5; 13 years old in group 5a; 14 years old in group 5b; 15 years old in 5c.).
[c] In the study 8, there are 3 subgroups according to age (9−11 years old in group 8; 12−14 years old in group 8a; 15−18 years old in group 8b).

those of TAO especially in SNB. The combined average range of the ANB value for this study was 1.56°−5.04° in male and 1.15°−4.55° in female, while for the TAO norm, it was 4.1°−5.7° in male and 3.2°−5° in female. Both results were smaller than TAO. The possible reason was that the SNB in TAO was smaller and would produce larger ANB. The ANB values were smaller in group C than in group B, showing that the mandible was growing more than the maxilla in teenage years, which was consistent with the growth pattern.[2] Regarding the position of the lips, only two studies included data of the U lip and L lip to the E-line, and samples were adults aged 18−30 years. The results in both genders were smaller than those of TAO. It might because when getting into adulthood, the lips are mostly getting less full than in teenage years.[2] The TAO norms were based on the results of 2−3 studies, and the original data could not be found, so it was difficult to realize the reasons of the difference

Table 2. Mean value and standard deviation in all groups and TAO.

	Group A 10–30 years old		Group B 10–14 years old		Group C 15–30 years old		Mean value range of TAO[b]	
	Male	Female	Male	Female	Male	Female	Male[b]	Female[b]
SNA	82.41 ± 3.22[c]	82.45 ± 3.28	82.07 ± 3.15	82.36 ± 3.26	84.02 ± 3.43	82.91 ± 3.19	80.95 (79.4–82.5)	81.5 (79.8–83.2)
SNB	79.17 ± 3.03	79.59 ± 3.1	78.76 ± 2.95	79.35 ± 3.08	80.93 ± 3.17	80.65 ± 3.05	76.2 (74.6–77.8)	77.2 (75.7–78.7)
ANB	3.30 ± 1.74	2.85 ± 1.7	3.32 ± 1.79	3.03 ± 1.73	3.21 ± 1.81	2.25 ± 1.55	4.9 (4.1–5.7)	4.1 (3.2–5.0)
SN-MP[a]	32.40 ± 4.41	32.11 ± 4.43	32.82 ± 4.15	32.59 ± 4.42	29.18 ± 5.87	30.00 ± 4.48	36.4 (34.2–38.6)	36.1 (33.8–38.4)
U1-NA (mm)	4.77 ± 2.18	4.86 ± 1.89	4.85 ± 2.14	4.78 ± 1.85	4.38 ± 2.37	5.26 ± 2.08	5.5 (3.8–7.2)	6.2 (4.3–8.1)
U1-SN	107.37 ± 5.88	107.09 ± 6.26	106.91 ± 5.97	106.81 ± 6.11	108.9 ± 5.52	108.68 ± 6.45	106.3 (103.5–109.1)	106.3 (103.85–108.75)
L1-NB (mm)	6.36 ± 2.07	5.73 ± 1.88	6.34 ± 2.00	5.65 ± 1.81	6.51 ± 2.46	6.22 ± 2.22	7.8 (6.1–9.5)	7.8 (5.4–10.2)
L1-MP[a]	98.06 ± 6.06	96.83 ± 6.02	98.03 ± 5.97	96.78 ± 5.97	98.26 ± 6.58	96.84 ± 6.28	94.7 (91.1–98.3)	96.3 (93.4–99.2)
U lip-Eline	0.32 ± 0.69	−1.26 ± 1.67			0.32 ± 0.69	−1.26 ± 1.67	2 (0.8–3.2)	1.9 (0.7–3.1)
L lip-Eline	0.62 ± 1.86	0.12 ± 1.98			0.62 ± 1.86	0.12 ± 1.98	2.8 (1.2–4.4)	1.8 (0.2–3.4)

[a] The definition of MP in groups A, B, and C is GoGn, while that in TAO is GoMe.
[b] TAO only showed the mean range originally. In this study, the midpoint was presented for easier comparison, and the original mean range given by TAO was put in brackets.
[c] The standard deviation shown in Table 2 was calculated from the standard error using the following formula: standard error = standard deviation/$\sqrt{N}$. (N = sample size).

Table 3. Mean values and standard errors of SNA.

SNA

Group A

Male

Study name	Mean	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
(1) Guo et al.,1970	81.500	0.438	0.192	80.641	82.359	185.901	0.000
(2) Wang et al.,1983	81.340	0.449	0.202	80.459	82.221	181.027	0.000
(3) Lin et al.,1985	80.490	0.473	0.224	79.563	81.417	170.217	0.000
(3a) Lin et al.,1985	82.110	0.601	0.361	80.933	83.287	136.698	0.000
(3b) Lin et al.,1985	81.690	0.593	0.352	80.527	82.853	137.672	0.000
(3c) Lin et al.,1985	82.510	0.562	0.316	81.408	83.612	146.729	0.000
(3d) Lin et al.,1985	82.130	0.637	0.406	80.881	83.379	128.895	0.000
(3e) Lin et al.,1985	83.930	0.705	0.497	82.549	85.311	119.094	0.000
(9) Chen et al.1977	81.440	0.629	0.396	80.207	82.673	129.411	0.000
(6) Hong et al.,1965	81.800	0.361	0.131	81.092	82.508	226.422	0.000
(5) Lin et al.,1985	83.700	0.366	0.134	82.983	84.417	228.832	0.000
(8) Fan et al.,1995	82.110	0.300	0.090	81.522	82.698	273.602	0.000
(8a) Fan et al.,1995	83.130	0.337	0.114	82.469	83.791	246.534	0.000
(8b) Fan et al.,1995	84.160	0.405	0.164	83.366	84.954	207.736	0.000
(4) Liu et al.,1986	83.360	0.593	0.352	82.197	84.523	140.487	0.000
	82.411	0.116	0.013	82.184	82.638	710.703	0.000

Female

Study name	Mean	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
(1) Guo et al.,1970	81.400	0.546	0.298	80.331	82.469	149.211	0.000
(2) Wang et al.,1983	83.060	0.605	0.366	81.874	84.246	137.260	0.000
(3) Lin et al.,1985	80.520	0.584	0.341	79.375	81.665	137.821	0.000
(3a) Lin et al.,1985	81.600	0.643	0.413	80.340	82.860	126.972	0.000
(3b) Lin et al.,1985	82.140	0.486	0.236	81.188	83.092	169.135	0.000
(3c) Lin et al.,1985	82.070	0.489	0.239	81.111	83.029	167.730	0.000
(3d) Lin et al.,1985	81.540	0.665	0.442	80.237	82.843	122.696	0.000
(3e) Lin et al.,1985	82.130	0.539	0.290	81.074	83.186	152.490	0.000
(6) Hong et al.,1965	82.120	0.441	0.194	81.256	82.984	186.221	0.000
(5) Lin et al.,1985	82.800	0.326	0.106	82.162	83.438	254.210	0.000
(8) Fan et al.,1995	82.740	0.315	0.099	82.122	83.358	262.563	0.000
(8a) Fan et al.,1995	82.880	0.283	0.080	82.325	83.435	292.820	0.000
(8b) Fan et al.,1995	83.970	0.495	0.245	83.000	84.940	169.683	0.000
(4) Liu et al.,1986	82.390	0.590	0.348	81.234	83.546	139.712	0.000
	82.454	0.120	0.014	82.219	82.689	688.134	0.000

Group B

Male

Study name	Mean	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
(1) Guo et al.,1970	81.500	0.438	0.192	80.641	82.359	185.901	0.000
(2) Wang et al.,1983	81.340	0.449	0.202	80.459	82.221	181.027	0.000
(3) Lin et al.,1985	80.490	0.473	0.224	79.563	81.417	170.217	0.000
(3a) Lin et al.,1985	82.110	0.601	0.361	80.933	83.287	136.698	0.000
(3b) Lin et al.,1985	81.690	0.593	0.352	80.527	82.853	137.672	0.000
(3c) Lin et al.,1985	82.510	0.562	0.316	81.408	83.612	146.729	0.000
(3d) Lin et al.,1985	82.130	0.637	0.406	80.881	83.379	128.895	0.000
(9) Chen et al.1977	81.440	0.629	0.396	80.207	82.673	129.411	0.000
(6) Hong et al.,1965	81.800	0.361	0.131	81.092	82.508	226.422	0.000
(5a) Lin et al.,1985	83.290	0.539	0.290	82.234	84.346	154.643	0.000
(5b) Lin et al.,1985	93.210	0.628	0.394	91.979	94.441	148.411	0.000
(8) Fan et al.,1995	82.110	0.300	0.090	81.522	82.698	273.602	0.000
(8a) Fan et al.,1995	83.130	0.337	0.114	82.469	83.791	246.534	0.000
	82.481	0.127	0.016	82.232	82.730	649.108	0.000

Female

Study name	Mean	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
(1) Guo et al.,1970	81.400	0.546	0.298	80.331	82.469	149.211	0.000
(2) Wang et al.,1983	83.060	0.605	0.366	81.874	84.246	137.260	0.000
(3) Lin et al.,1985	80.520	0.584	0.341	79.375	81.665	137.821	0.000
(3a) Lin et al.,1985	81.600	0.643	0.413	80.340	82.860	126.972	0.000
(3b) Lin et al.,1985	82.140	0.486	0.236	81.188	83.092	169.135	0.000
(3c) Lin et al.,1985	82.070	0.489	0.239	81.111	83.029	167.730	0.000
(3d) Lin et al.,1985	81.540	0.665	0.442	80.237	82.843	122.696	0.000
(6) Hong et al.,1965	82.120	0.441	0.194	81.256	82.984	186.221	0.000
(5a) Lin et al.,1985	83.180	0.486	0.236	82.228	84.132	171.277	0.000
(5b) Lin et al.,1985	82.340	0.679	0.461	81.009	83.671	121.235	0.000
(8) Fan et al.,1995	82.740	0.315	0.099	82.122	83.358	262.563	0.000
(8a) Fan et al.,1995	82.880	0.283	0.080	82.325	83.435	292.820	0.000
	82.359	0.133	0.018	82.098	82.621	617.562	0.000

Group C

Male

Study name	Mean	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
(3e) Lin et al.,1985	83.930	0.705	0.497	82.549	85.311	119.094	0.000
(5c) Lin et al.,1985	84.620	0.710	0.504	83.228	86.012	119.147	0.000
(8b) Fan et al.,1995	84.160	0.405	0.164	83.366	84.954	207.736	0.000
(4) Liu et al.,1986	83.360	0.593	0.352	82.197	84.523	140.487	0.000
	84.019	0.278	0.077	83.474	84.564	302.106	0.000

Female

Study name	Mean	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
(3e) Lin et al.,1985	82.130	0.539	0.290	81.074	83.186	152.490	0.000
(5c) Lin et al.,1985	82.880	0.513	0.263	81.874	83.886	161.549	0.000
(8b) Fan et al.,1995	83.970	0.495	0.245	83.000	84.940	169.683	0.000
(4) Liu et al.,1986	82.390	0.590	0.348	81.234	83.546	139.712	0.000
	82.912	0.265	0.070	82.392	83.432	312.499	0.000

*The study name of 3, 3a, 3b, 3c, 3d, 3e, 5, 5a, 5b, 5c, 8, 8a, 8b are subgroups by age in the studies of 3, 5, and 8. Please see Table 1.
**The sample size and sample age of every study are shown in Table 1.

between the results in this study and the TAO norms. The results in this study maybe were more representative.

Group C had a small sample size because of the lack of adult samples. Schoolchildren accounted for the larger proportion of the samples of all studies. The possible reasons were as follows: (1) Most of authors went to junior high school to recruit participants. (2) Schoolchildren in campus were more likely to cooperate with the inspection, and a larger number of samples could also be collected in junior high school. (3) If the authors wanted to find a large number of adult participants, they could only visit universities or hospitals. The cooperation of university students might be relatively low because of the unspecified class time. Moreover, most of the patients visiting hospitals mostly had orthodontic needs, which did not meet the inclusion criteria.

The ANB of group C was 3.21° ± 1.81° in male and 2.25° ± 1.55° in female in Taiwan. Compared with

Table 4. Mean values and standard errors of SNB.

SNB

Group A

Male

Study name	Mean	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
(1) Guo et al.,1970	77.700	0.368	0.135	76.979	78.421	211.316	0.000
(2) Wang et al.,1983	78.390	0.466	0.218	77.476	79.304	168.047	0.000
(3) Lin et al.,1985	77.480	0.519	0.269	76.464	78.496	149.428	0.000
(3a) Lin et al.,1985	78.730	0.617	0.381	77.521	79.939	127.580	0.000
(3b) Lin et al.,1985	78.730	0.542	0.294	77.667	79.793	145.193	0.000
(3c) Lin et al.,1985	79.710	0.451	0.203	78.826	80.594	176.757	0.000
(3d) Lin et al.,1985	79.640	0.590	0.348	78.484	80.796	135.048	0.000
(3e) Lin et al.,1985	80.510	0.566	0.320	79.401	81.619	142.249	0.000
(9) Chen et al.1977	77.180	0.498	0.248	76.203	78.157	154.841	0.000
(5) Lin et al.,1985	80.750	0.310	0.096	80.143	81.357	260.565	0.000
(8) Fan et al.,1995	78.230	0.264	0.070	77.712	78.748	296.096	0.000
(8a) Fan et al.,1995	79.580	0.342	0.117	78.910	80.250	232.941	0.000
(8b) Fan et al.,1995	81.230	0.378	0.143	80.488	81.972	214.633	0.000
(4) Liu et al.,1986	80.210	0.703	0.494	78.832	81.588	114.111	0.000
	79.167	0.113	0.013	78.947	79.388	703.607	0.000

Study name	Mean	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
(1) Guo et al.,1970	77.800	0.457	0.209	76.904	78.696	170.215	0.000
(2) Wang et al.,1983	79.880	0.499	0.249	78.903	80.857	160.195	0.000
(3) Lin et al.,1985	77.890	0.586	0.343	76.741	79.039	132.904	0.000
(3a) Lin et al.,1985	78.770	0.632	0.399	77.532	80.008	124.694	0.000
(3b) Lin et al.,1985	79.830	0.484	0.234	78.882	80.778	164.999	0.000
(3c) Lin et al.,1985	79.470	0.477	0.227	78.536	80.404	166.772	0.000
(3d) Lin et al.,1985	79.010	0.718	0.515	77.604	80.416	110.116	0.000
(3e) Lin et al.,1985	80.130	0.477	0.227	79.196	81.064	168.157	0.000
(5) Lin et al.,1985	80.410	0.331	0.110	79.761	81.059	242.941	0.000
(8) Fan et al.,1995	79.030	0.296	0.088	78.450	79.610	267.022	0.000
(8a) Fan et al.,1995	79.780	0.257	0.066	79.277	80.283	310.963	0.000
(8b) Fan et al.,1995	81.520	0.504	0.254	80.532	82.508	161.649	0.000
(4) Liu et al.,1986	79.950	0.597	0.356	78.780	81.120	133.916	0.000
	79.589	0.118	0.014	79.357	79.820	674.031	0.000

Group B

Study name	Mean	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
(1) Guo et al.,1970	77.700	0.368	0.135	76.979	78.421	211.316	0.000
(2) Wang et al.,1983	78.390	0.466	0.218	77.476	79.304	168.047	0.000
(3) Lin et al.,1985	77.480	0.519	0.269	76.464	78.496	149.428	0.000
(3a) Lin et al.,1985	78.730	0.617	0.381	77.521	79.939	127.580	0.000
(3b) Lin et al.,1985	78.730	0.542	0.294	77.667	79.793	145.193	0.000
(3c) Lin et al.,1985	79.710	0.451	0.203	78.826	80.594	176.757	0.000
(3d) Lin et al.,1985	79.640	0.590	0.348	78.484	80.796	135.048	0.000
(9) Chen et al.1977	77.180	0.498	0.248	76.203	78.157	154.841	0.000
(5a) Lin et al.,1985	80.390	0.431	0.186	79.546	81.234	186.574	0.000
(5b) Lin et al.,1985	80.700	0.599	0.359	79.526	81.874	134.760	0.000
(8) Fan et al.,1995	78.230	0.264	0.070	77.712	78.748	296.096	0.000
(8a) Fan et al.,1995	79.580	0.342	0.117	78.910	80.250	232.941	0.000
	78.760	0.124	0.015	78.516	79.004	633.147	0.000

Study name	Mean	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
(1) Guo et al.,1970	77.800	0.457	0.209	76.904	78.696	170.215	0.000
(2) Wang et al.,1983	79.880	0.499	0.249	78.903	80.857	160.195	0.000
(3) Lin et al.,1985	77.890	0.586	0.343	76.741	79.039	132.904	0.000
(3a) Lin et al.,1985	78.770	0.632	0.399	77.532	80.008	124.694	0.000
(3b) Lin et al.,1985	79.830	0.484	0.234	78.882	80.778	164.999	0.000
(3c) Lin et al.,1985	79.470	0.477	0.227	78.536	80.404	166.772	0.000
(3d) Lin et al.,1985	79.010	0.718	0.515	77.604	80.416	110.116	0.000
(5a) Lin et al.,1985	80.570	0.482	0.232	79.625	81.515	167.159	0.000
(5b) Lin et al.,1985	79.810	0.732	0.536	78.375	81.245	109.012	0.000
(8) Fan et al.,1995	79.030	0.296	0.088	78.450	79.610	267.022	0.000
(8a) Fan et al.,1995	79.780	0.257	0.066	79.277	80.283	310.963	0.000
	79.349	0.132	0.017	79.090	79.607	602.332	0.000

Group C

Study name	Mean	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
(3e) Lin et al.,1985	80.510	0.566	0.320	79.401	81.619	142.249	0.000
(5c) Lin et al.,1985	81.160	0.575	0.331	80.033	82.287	141.121	0.000
(8b) Fan et al.,1995	81.230	0.378	0.143	80.488	81.972	214.633	0.000
(4) Liu et al.,1986	80.210	0.703	0.494	78.832	81.588	114.111	0.000
	80.931	0.257	0.066	80.428	81.435	315.018	0.000

Study name	Mean	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
(3e) Lin et al.,1985	80.130	0.477	0.227	79.196	81.064	168.157	0.000
(5c) Lin et al.,1985	80.850	0.471	0.222	79.927	81.773	171.641	0.000
(8b) Fan et al.,1995	81.520	0.504	0.254	80.532	82.508	161.649	0.000
(4) Liu et al.,1986	79.950	0.597	0.356	78.780	81.120	133.916	0.000
	80.654	0.253	0.064	80.159	81.150	319.054	0.000

*The study name of 3, 3a, 3b, 3c, 3d, 3e, 5, 5a, 5b, 5c, 8, 8a, 8b are subgroups by age in the studies of 3, 5, and 8. Please see Table 1.
**The sample size and sample age of every study are shown in Table 1.

other East Asians, including 2.6° ± 1.7° in male and 2.4° ± 1.9° in female in Korea,[28] 2.8° ± 2° in male and 3.3° ± 1.8° in female in Japan,[29] and 3.5° ± 1.4° in male and 3.9° ± 1.8° in female in China residing outside Guangdong and Fujian provinces,[30] Taiwanese men showed more Class II tendency than Korean and Japanese men and less facial convexity than Japanese and Chinese women. Compared with other Asians, including 1.6° ± 2.8° (male) and 2.1° ± 2.4° (female) in Bengal,[31] 2.1° ± 1.7° (male) and 2.9° ± 1.6° (female) in Turkey,[32] 2.5° ± 2.4° (male) and 4.1° ± 1.4° (female) in Saudi Arabia,[32] and 3° ± 3.11° (male) and 3.3° ± 2.4° (female) in UAE,[33] Taiwanese men showed more Class II classification than men adults from these countries and less facial

Table 5. Mean values and standard errors of ANB.

ANB

Group A

Male

Study name	Mean	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
(1) Guo et al.,1970	4.100	0.255	0.065	3.601	4.599	16.106	0.000
(2) Wang et al.,1983	2.950	0.281	0.079	2.399	3.501	10.489	0.000
(3) Lin et al.,1985	3.010	0.272	0.074	2.477	3.543	11.065	0.000
(3a) Lin et al.,1985	3.370	0.261	0.068	2.858	3.882	12.908	0.000
(3b) Lin et al.,1985	2.960	0.248	0.062	2.473	3.447	11.921	0.000
(3c) Lin et al.,1985	2.810	0.298	0.089	2.227	3.393	9.442	0.000
(3d) Lin et al.,1985	2.490	0.292	0.085	1.917	3.063	8.524	0.000
(3e) Lin et al.,1985	3.430	0.299	0.090	2.843	4.017	11.455	0.000
(9) Chen et al.1977	4.260	0.458	0.210	3.362	5.158	9.301	0.000
(5) Lin et al.,1985	2.960	0.173	0.030	2.621	3.299	17.123	0.000
(8) Fan et al.,1995	3.880	0.167	0.028	3.553	4.207	23.286	0.000
(8a) Fan et al.,1995	3.550	0.178	0.032	3.200	3.900	19.904	0.000
(8b) Fan et al.,1995	2.930	0.246	0.061	2.447	3.413	11.892	0.000
(4) Liu et al.,1986	3.080	0.372	0.139	2.350	3.810	8.270	0.000
	3.301	0.065	0.004	3.173	3.428	50.710	0.000

Study name	Mean	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
(1) Guo et al.,1970	4.000	0.265	0.070	3.480	4.520	15.072	0.000
(2) Wang et al.,1983	3.180	0.243	0.059	2.703	3.657	13.065	0.000
(3) Lin et al.,1985	2.620	0.237	0.056	2.155	3.085	11.039	0.000
(3a) Lin et al.,1985	2.830	0.352	0.124	2.139	3.521	8.031	0.000
(3b) Lin et al.,1985	2.310	0.303	0.092	1.716	2.904	7.622	0.000
(3c) Lin et al.,1985	2.600	0.321	0.103	1.970	3.230	8.091	0.000
(3d) Lin et al.,1985	2.540	0.259	0.067	2.032	3.048	9.797	0.000
(3e) Lin et al.,1985	2.000	0.261	0.068	1.488	2.512	7.660	0.000
(5) Lin et al.,1985	2.420	0.162	0.026	2.102	2.738	14.908	0.000
(8) Fan et al.,1995	3.710	0.179	0.032	3.359	4.061	20.713	0.000
(8a) Fan et al.,1995	3.100	0.173	0.030	2.761	3.439	17.922	0.000
(8b) Fan et al.,1995	2.450	0.293	0.086	1.877	3.023	8.373	0.000
(4) Liu et al.,1986	2.440	0.241	0.058	1.968	2.912	10.125	0.000
	2.847	0.065	0.004	2.720	2.974	43.969	0.000

Group B

Study name	Mean	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
(1) Guo et al.,1970	4.100	0.255	0.065	3.601	4.599	16.106	0.000
(2) Wang et al.,1983	2.950	0.281	0.079	2.399	3.501	10.489	0.000
(3) Lin et al.,1985	3.010	0.272	0.074	2.477	3.543	11.065	0.000
(3a) Lin et al.,1985	3.370	0.261	0.068	2.858	3.882	12.908	0.000
(3b) Lin et al.,1985	2.960	0.248	0.062	2.473	3.447	11.921	0.000
(3c) Lin et al.,1985	2.810	0.298	0.089	2.227	3.393	9.442	0.000
(3d) Lin et al.,1985	2.490	0.292	0.085	1.917	3.063	8.524	0.000
(9) Chen et al.1977	4.260	0.458	0.210	3.362	5.158	9.301	0.000
(5a) Lin et al.,1985	2.890	0.288	0.083	2.325	3.455	10.018	0.000
(5b) Lin et al.,1985	2.520	0.301	0.091	1.930	3.110	8.365	0.000
(8) Fan et al.,1995	3.880	0.167	0.028	3.553	4.207	23.286	0.000
(8a) Fan et al.,1995	3.550	0.178	0.032	3.200	3.900	19.904	0.000
	3.323	0.072	0.005	3.181	3.464	45.887	0.000

Study name	Mean	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
(1) Guo et al.,1970	4.000	0.265	0.070	3.480	4.520	15.072	0.000
(2) Wang et al.,1983	3.180	0.243	0.059	2.703	3.657	13.065	0.000
(3) Lin et al.,1985	2.620	0.237	0.056	2.155	3.085	11.039	0.000
(3a) Lin et al.,1985	2.830	0.352	0.124	2.139	3.521	8.031	0.000
(3b) Lin et al.,1985	2.310	0.303	0.092	1.716	2.904	7.622	0.000
(3c) Lin et al.,1985	2.600	0.321	0.103	1.970	3.230	8.091	0.000
(3d) Lin et al.,1985	2.540	0.259	0.067	2.032	3.048	9.797	0.000
(5a) Lin et al.,1985	2.610	0.336	0.113	1.952	3.268	7.769	0.000
(5b) Lin et al.,1985	2.530	0.257	0.066	2.025	3.035	9.828	0.000
(8) Fan et al.,1995	3.710	0.179	0.032	3.359	4.061	20.713	0.000
(8a) Fan et al.,1995	3.100	0.173	0.030	2.761	3.439	17.922	0.000
	3.032	0.074	0.006	2.886	3.178	40.780	0.000

Group C

Study name	Mean	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
(3e) Lin et al.,1985	3.430	0.299	0.090	2.843	4.017	11.455	0.000
(5c) Lin et al.,1985	3.460	0.294	0.086	2.884	4.036	11.771	0.000
(8b) Fan et al.,1995	2.930	0.246	0.061	2.447	3.413	11.892	0.000
(4) Liu et al.,1986	3.080	0.372	0.139	2.350	3.810	8.270	0.000
	3.206	0.147	0.022	2.918	3.493	21.838	0.000

Study name	Mean	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
(3e) Lin et al.,1985	2.000	0.261	0.068	1.488	2.512	7.660	0.000
(5c) Lin et al.,1985	2.130	0.245	0.060	1.650	2.610	8.706	0.000
(8b) Fan et al.,1995	2.450	0.293	0.086	1.877	3.023	8.373	0.000
(4) Liu et al.,1986	2.440	0.241	0.058	1.968	2.912	10.125	0.000
	2.249	0.129	0.017	1.996	2.501	17.460	0.000

*The study name of 3, 3a, 3b, 3c, 3d, 3e, 5, 5a, 5b, 5c, 8, 8a, 8b are subgroups by age in the studies of 3, 5, and 8. Please see Table 1.
**The sample size and sample age of every study are shown in Table 1.

convexity than adult Saudi Arabian, Turk, and Emirati women.

The limitations of this study were as follows: (1) The age boundary of the group depended on whether the original data had been recorded or not, not according to the growth spurt in different genders. Therefore, it was difficult to compare the values before and after the growth spurt. (2) Schoolchildren made up the majority of the study sample, and the sample size of adults was small, which might cause bias in the results. (3) Although the samples collected in this study were all Taiwanese, there might be bias in the sample selection by different authors. Also, there might be measurement error including system error and random error. System error included the different head position when taking cephalometric films or different radiographic machine. Random error included tracing error. In the 10 studies, only one study[24] considered the measurement error in the methods design, which might affect the accuracy of results. (4) TAO did not give information of the sample size, sample age, mean value, and standard deviation, so the meta-analysis with other studies could not be made.

CONCLUSION

This study integrated results of previous studies of cephalometric standard values in Taiwanese population and provided a stronger statistical support for Taiwanese norms through a meta-analysis. Moreover, the ANB norm of TAO was found to be larger and the SNB of TAO was smaller, i.e., beyond the clinical experiences in Taiwanese population. This study provides a new reference for the establishment of Taiwanese norm values in the future.

Conflict of Interest Statement

The authors claim that there are no competing interests.

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