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Does Chin-Throat Length Relate to Oropharyngeal Volume, Minimum Axial Area, and Polysomnographic Indices?

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ABSTRACT

OBJECTIVE To evaluate the correlation between chin-throat length and oropharyngeal volume, minimum axial area, and polysomnographic indices in patients undergoing orthodontic treatment.

METHODS The study enrolled 73 patients (35 men and 38 women) who met the inclusion criteria. The face scanner created a 3D facial simulation, and chin-throat length was subsequently measured. 3D CBCT images were used to simulate 2D lateral cephalometric images. Oropharyngeal volume and minimum axial area were determined using Dolphin imaging software, and airway function was assessed through unattended at-home overnight polysomnography. Pearson correlation coefficients were then used to determine the correlations between chin-throat length and oropharyngeal volume, minimum axial area, and polysomnographic indices. Additional correlations were explored between age, BMI, cephalometric variables, and oropharyngeal volume, and minimum axial area. Finally, multiple regression analysis was used to analyse the factors having an influence on the correlations.

RESULTS Chin-throat length was positively correlated with oropharyngeal volume and minimum axial area. SNB, ANB, Co-Gn, and Go-Gn were also observed to be positively correlated with oropharyngeal volume and minimum axial area. Multiple regression analysis demonstrated that the factor influencing the correlation of chin-throat length with oropharyngeal volume and with minimum axial area was mandibular length; however, the correlations were only observed among men. No correlation was evident between chin-throat length and polysomnographic indices.

CONCLUSIONS Chin-throat length is positively correlated with oropharyngeal volume and minimum axial area but has no association with polysomnographic indices. Mandibular length may influence upper airway dimensions.

KEYWORDS chin-throat length, oropharyngeal volume, minimum axial area, polysomnographic indices

INTRODUCTION

Obstructive sleep apnea (OSA) is a chronic sleep-related disorder that has been widely studied in orthodontics over the past decade because of the severity and prevalence of the disease, which affects approximately 9% to 38% of the adult population worldwide (1). OSA is a multifactorial disorder, and its associated risk factors include obesity, age (i.e., increasing risk with age), male gender, metabolic syndrome, craniofacial anatomy, and upper airway abnormalities (2). Obesity is one of the major risk factors of OSA, but only a small number of patients with OSA in Asia are obese (3). Given the apparently lesser role of obesity in OSA among Asians, craniofacial anatomical factors might play a key role in the pathogenesis of OSA in Asian populations (4). Several researchers have investigated using craniofacial anatomy as a predictive factor for OSA because using polysomnography (PSG), the standard approach, features has several disadvantages, namely high cost, limited accessibility, and a need for technician control (5). Studies on craniofacial anatomy as a predictive factor have focused on skeletal features and soft tissues. In this context, Hong et al. investigated the impact of mandibular position on pharyngeal airway volume using 3D analysis (6). Their findings highlighted a noteworthy correlation which indicates that anterior mandibular position is associated with increased upper pharyngeal airway volume. However, the use of skeletal features in evaluations necessitates radiographic imaging modalities, potentially diminishing clinical utility. By contrast, the use of soft tissue features does not require the use of those modalities and may represent a clinically useful approach to OSA prediction. Various soft tissue studies have investigated the relationship between soft tissue phenotypes and OSA. Mallampati score, tonsil size, and neck circumference have been identified as potential risk factors for factors potentially related to OSA incidence, but other soft tissue features, including chin-throat length have been neglected (7, 8).

In orthodontics, chin-throat length is one of the main parameters used to evaluate potential orthodontic or orthognathic interventions, as well as to predict aesthetic outcomes (9). Some studies have determined that mandibular setback surgery is contraindicated in patients with a short chin-throat length because this procedure might negatively affect their upper airway (10). However, no solid evidence has demonstrated that the relationship between chin-throat length and upper airway morphology can be used to infer the risk of OSA.

Due to the clinical usefulness of soft tissue in predicting OSA and the lack of evidence supporting the association between chin-throat length and upper airway morphology, this study aimed to evaluate the correlations between chin-throat length and oropharyngeal volume, minimum axial area, and polysomnographic indices in patients undergoing orthodontic treatment using a three-dimensional (3D) face scanner, cone-beam computed tomography (CBCT), unattended at-home overnight PSG (SOMNOlab 2), and Dolphin imaging software.

METHODS
Subjects and selection criteria

This study was approved by the human experimentation committee of our institution (No. 68/2563). The study sample comprised 73 Thai patients (35 men and 38 women) who underwent orthodontic treatment and orthodontic consultation from October 2020 to December 2021. All patients who met the inclusion criteria were invited to participate in the study.

The inclusion criteria were age between 15 and 35 years, being in good health, and having a BMI of less than 23 kg/m². Patients with craniofacial syndromes or systemic diseases and those who had received previous orthodontic treatment or orthognathic surgery were excluded from the study. All patients signed the consent forms, and for those who were under the age of 18, the consent forms were signed by their parents or legal guardians.

Study variables

The independent variables and outcome variables of the study are specified in Table 1.

Face scanning and measurement

Patients' faces were scanned using an Accu 3D face scanner (Digident Image Technology, Taichung, Taiwan) after which facial simulations were generated. Soft tissue landmarks, namely the soft tissue menton (Me') and neck-throat

Correlation of chin-throat length with oropharyngeal volume, minimum axial area, and polysomnographic indices (97 characters)

Chin-throat length and airway correlation

Table 1. Independent variables and outcome variables

Independent variables	Outcome variables
Chin-throat length (mm)	Upper airway dimensions
Age (year)	- Oropharyngeal volume (mm^3)
BMI (km/m^2)	- Minimum axial area (mm^2)
Cephalometric variables	Polysomnographic indices
- SNA (degree)	- AHI (events/hour)
- SNB (degree)	- ODI (events/hour)
- ANB (degree)	- Lowest oxygen saturation (%)
- FMA (degree)	- Average oxygen saturation (%)
- Co-A (mm)	
- Co-Gn (mm)	
- Go-Gn (mm)	

point (C-point), were identified (Fig. 1A). In accordance with the approach of Naini and Gill, (11) chin-throat length was defined as the distance from the Me' to C-point (Fig. 1B).
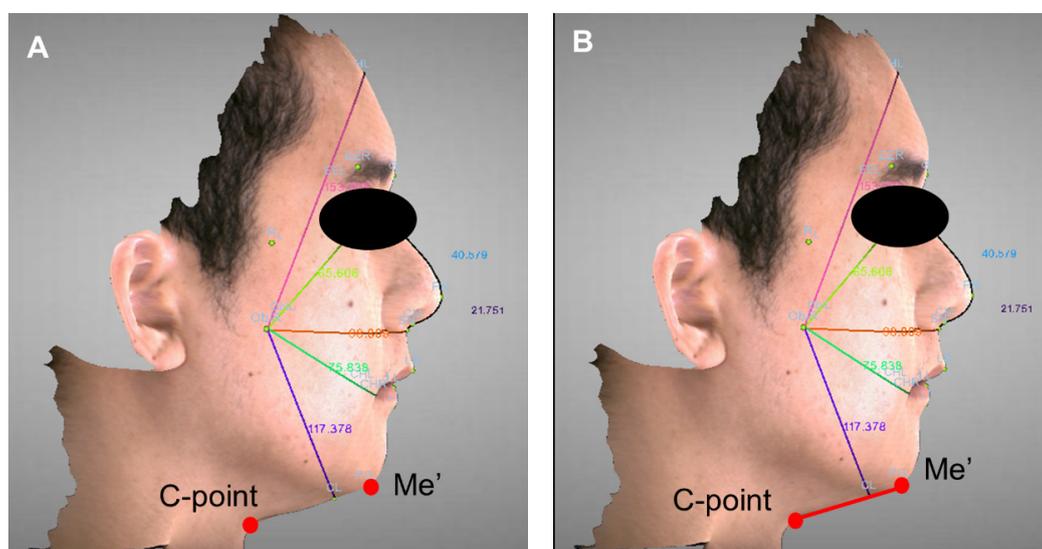
Upper airway measurement

CBCT scans were taken using MobiiScan (NSTDA, Bangkok, Thailand) with the following parameters: 90 kV, 8 mA, 22 cm x 18 cm field of view, and 0.4 mm voxel size. DICOM data obtained from CBCT were processed using third-party software (Dolphin Imaging Software Version 11.9, Dolphin Imaging & Management Solutions, Chatsworth, CA, USA). During the scanning process, conscious participants were instructed to consistently maintain maximum intercuspation, position the tongue against the hard palate, breathe in a normal manner, and refrain from swallowing.

The plane orientation was manually applied for each patient using the approach adopted by Guijarro-Martinez and Swennen (12). All CBCT images were examined using a craniocervical inclination that was defined by the intersection between the S-N plane and the C2p-C2lp plane (from the uppermost posterior point of the second cervical vertebra to the lowermost posterior point of the second cervical vertebra). This angle must fall within a range of 90° to 110°, otherwise the upper airway dimension may be inaccurately calculated (13). Subsequently, the threshold value (average: 70) of the upper airway morphology was manually adjusted until the pharyngeal airway was adequately depicted. The upper airway morphology was measured using Guijarro-Martinez and Swennen's (12) method, which is based on oropharyngeal volume (Fig. 2A) and minimum axial area (Fig. 2B). The Dolphin imaging software automatically calculated the oropharyngeal airway volume (mm^3) and minimum axial area (mm^2).

Airway function assessment

The patients underwent evaluation of their upper airway function. The evaluation was conducted using an unattended at-home overnight PSG system, SOMNOlab 2 (Fig. 3). Expert specialists gave the patients comprehensive instructions on the precise assembly and operation of the SOMNOlab 2 monitor. The PSG recordings were analysed by a board-qualified physician. OSA was diagnosed in patients whose apnea-hypopnea index (AHI) was more than five events per hour.

Figure 1. Landmarks and measurements. (A) Soft tissue landmarks: soft tissue menton (Me') and neck-throat point (C-point). (B) Chin-throat length measurement.
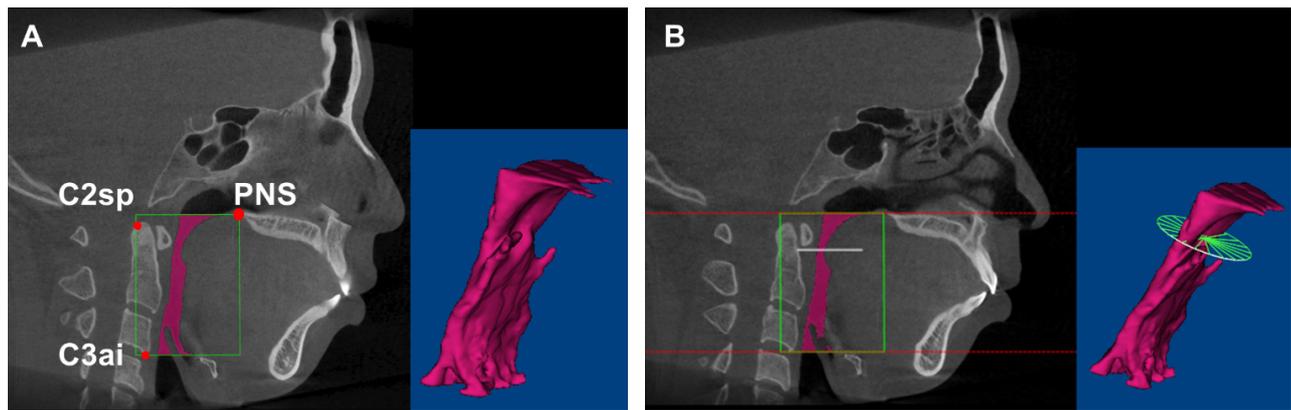
Figure 2. Landmarks and measurements of upper airway dimensions. (A) Oropharyngeal volume landmarks: posterior nasal spine (PNS), most super posterior point of the second cervical vertebrae (C2sp), and most anteroinferior aspect of the third cervical vertebrae (C3ai). (B) Minimum axial area.

Figure 3. An unattended at-home overnight PSG system (SOMNOlab 2)

Cephalometric analysis

Two-dimensional (2D) lateral cephalometric images were simulated on the basis of 3D CBCT images. Linear and angular measurements of the angle indicating the horizontal position of the maxilla relative to the cranial base (SNA), the angle indicating the horizontal position of the mandible relative to the cranial base (SNB), the angle measuring the relative position of the maxilla to the mandible (ANB), the angle between the Frankfort horizontal plane and the mandibular plane (FMA), the maxillary length from the condylion to A point (Co-A), the mandibular length from the condylion to gnathion (Co-Gn), and the mandibular length from the gonion to gnathion (Go-Gn) were recorded.

Statistical analysis

The sample size was calculated using G*Power (Version 3.1.9.4, University of Kiel, Kiel, Germany).

For a correlation of 0.4, a power of 80%, and a significance level of 5%, the final minimum sample size was 47 patients.

To test the reliability of the measurements, the chin-throat length and upper airway morphology of randomly selected patients were measured. Over the subsequent 4 weeks, the measurements of the patients were retaken by the same examiner. Intraclass correlation coefficients (ICCs) was then used to perform the intra-variation assessment.

SPSS Version 25.0 for Windows (SPSS Inc., Chicago, IL, USA) was used to calculate all statistical results, and descriptive analysis was applied to determine the means and standard deviations of the data. The normality of the variables was assessed using the Kolmogorov-Smirnov test. The results indicated that the distribution of all variables did not significantly deviate from a normal distribution ($p > 0.05$), supporting the assumption of normality for subsequent statistical analyses. The correlations between chin-throat length and upper airway dimensions and function were tested using the Pearson correlation coefficient. The results were considered statistically significant at $p < 0.05$. The Potentially influencing factors were assessed through multiple regression analysis using a stepwise method.

RESULTS

Data were collected from 73 patients (35 men and 38 women) ranging in age from 15 to 35 years (mean age: 22.70 ± 5.15 years). Patient BMI ranged from 15.78 to 23.00 kg/m^2 (mean BMI: 20.58 ± 1.92 kg/m^2), and the mean chin-throat length was 40.76 ± 5.72 mm.

CBCT imaging was used to categorise patients into skeletal class I (23 patients), class II (28 patients), and class III (22 patients). The means and standard deviations of chin-throat length divided by sagittal skeletal pattern were calculated, and the lengths of the groups were as follows: 41.58 ± 5.07 mm in skeletal class I patients, 38.94 ± 6.29 mm in class II patients, and 43.72 ± 4.81 mm in class III patients. The CCA of all patients fell within the range of 90° to 110° (mean CCA: 96.71 ± 6.57 degrees). The descriptive analysis of all variables with respect to gender and OSA diagnosis is presented in Table 2.

The airway function of 73 patients was measured. Four polysomnographic indices were recorded: AHI, oxygen desaturation index (ODI), lowest oxygen saturation, and average oxygen saturation. Eight patients, comprising 5 men and 3 women, with ages ranging from 15 to 31 years (mean age: 23.25 ± 5.25 years), were diagnosed with OSA based on an AHI exceeding five events per hour (range: 6.0 to 30.3 events per hour). The means and standard deviations of the polysomnographic indices are detailed in Table 2.

Pearson correlation coefficients were then used to determine the relationship of oropharyngeal volume and minimum axial area with chin-throat length and other factors, including age, BMI, and cephalometric variables. Oropharyngeal volume and minimal axial area were slightly positively correlated with chin-throat length. SNB, ANB, Co-Gn, and Go-Gn were each correlated with both oropharyngeal volume and minimum axial area. Additionally, chin-throat length was

Table 2. Means and standard deviations of all variables with respect to gender and OSA diagnosis

Variables	Gender			OSA		
	Male (n = 35) Mean ± SD	Female (n = 38) Mean ± SD	p-value	Non-OSA (n = 65) Mean ± SD	OSA (n = 8) Mean ± SD	p-value
BMI (kg/m²)	21.21±1.94	20.00±1.73	0.007**	20.54±1.96	20.86±1.66	0.630
Chin-throat length (mm)	40.99±5.41	40.54±6.06	0.730	40.76±5.54	40.74±7.49	0.990
Cephalometric variables						
- SNA (degree)	83.30±4.05	84.49±3.51	0.190	83.88±3.74	83.80±4.30	0.950
- SNB (degree)	80.26±6.47	82.74±5.42	0.090	81.28±5.86	83.36±7.15	0.450
- ANB (degree)	3.02±4.92	1.74±4.99	0.280	2.59±4.83	0.43±5.40	0.310
- FMA (degree)	23.59±6.88	24.88±5.36	0.380	24.23±6.09	25.46±6.86	0.640
- Co-A (mm)	96.00±5.13	89.36±5.05	< 0.001***	92.56±6.16	92.70±5.35	0.940
- Co-Gn (mm)	131.31±8.59	124.13±8.53	0.001**	127.06±9.39	131.65±6.53	0.100
- Go-Gn (mm)	82.63±7.21	78.13±5.92	0.006**	80.13±7.17	81.80±6.36	0.500
Upper airway dimensions						
- Oropharyngeal volume (mm³)	14,508.88±5,239.69	12,590.92±4,842.60	0.110	13,365.75±5,189.86	14,399.50±4,392.79	0.550
- Minimum axial area (mm²)	146.05±78.32	135.02±74.91	0.550	142.27±76.10	125.75±80.80	0.590
Polysomnographic indices						
- AHI (events/hour)	2.70±5.44	1.45±3.29	0.240	0.80±0.93	12.21±8.04	0.005**
- ODI (events/hour)	1.78±2.23	1.31±1.77	0.320	1.36±1.82	2.97±2.90	0.160
- Lowest oxygen saturation (%)	85.82±5.05	85.44±6.51	0.780	86.93±5.42	82.37±8.12	0.250
- Average oxygen saturation (%)	96.63±1.36	97.39±0.71	0.005*	97.03±1.17	96.98±0.73	0.870

SD, standard deviation; statistically significant difference, $^*p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

correlated with oropharyngeal volume and minimal axial area in male patients only (Table 3).

The correlations between chin-throat length and polysomnographic indices were further analysed using the Pearson correlation coefficient. No correlation was noted between chin-throat length and upper airway function as represented in Table 4.

The Pearson correlation coefficient was also used to assess the relationship between oropharyngeal volume and minimum axial area and polysomnographic indices. No significant correlations were observed between oropharyngeal volume and polysomnographic indices. Similarly, no significant correlations were detected between

minimum axial area and polysomnographic indices, as outlined in Table 5.

The influencing factors of oropharyngeal volume and minimum axial area were then investigated using multiple regression analysis with a stepwise method, and age, gender, BMI, cephalometric variables (SNA, SNB, ANB, FMA, CO-A, Co-Gn, and Go-Gn), and chin-throat length were included as independent variables. Multiple regression analysis indicated that Co-Gn was related to oropharyngeal volume (R^2 = 17.8%, $p < 0.01$) and minimum axial area (R^2 = 14.7%, $p = 0.01$; Table 6).

The intraexaminer reliability tests for chin-throat length and oropharyngeal volume revealed

Table 3. Pearson correlation coefficients for chin-throat length, age, BMI, and cephalometric variables in relation to oropharyngeal volume and minimum axial area.

		OP (mm³)	p-value	Min (mm²)	p-value
TL (n = 73)	r	0.26*	0.029*	0.193	0.110
	R²	0.068		0.037	
TL male (n = 35)	r	0.449**	< 0.010**	0.43*	0.011*
	R²	0.202		0.185	
TL female (n = 38)	r	0.094	0.580	−0.017	0.920
	R²	0.009		0.000	
Age (year)	r	−0.074	0.542	−0.137	0.259
	R²	0.005		0.019	
BMI (km/m²)	r	−0.076	0.528	−0.115	0.344
	R²	0.006		0.013	
SNA (degree)	r	0.079	0.518	0.166	0.170
	R²	0.006		0.028	
SNB (degree)	r	0.337*	0.004*	0.34*	0.004*
	R²	0.114		0.116	
ANB (degree)	r	−0.351**	< 0.010**	−0.289*	0.015*
	R²	0.123		0.084	
FMA (degree)	r	−0.108	0.372	−0.172	0.154
	R²	0.012		0.030	
Co-A (mm)	r	0.187	0.121	0.200	0.096
	R²	0.035		0.04	
Co-Gn (mm)	r	0.422**	< 0.010**	0.384**	< 0.010**
	R²	0.178		0.147	
Go-Gn (mm)	r	0.404**	< 0.010**	0.341**	< 0.010**
	R²	0.163		0.116	

TL, chin-throat length; OP, oropharyngeal volume; min, minimum axial area; R², coefficient of determination; statistically significant difference, *$p < 0.05$; **$p < 0.01$.

Table 4. Pearson correlation coefficients for chin-throat length in relation to polysomnographic indices.

		AHI	p-value	ODI	p-value	Lowest oxygen saturation	p-value	Average oxygen saturation	p-value
TL (n = 73)	r	-0.028	0.818	-0.074	0.533	0.141	0.246	0.062	0.608
	R²	0.001		0.284		0.020		0.004	

TL, chin-throat length; R², coefficient of determination.

Table 5. Pearson correlation coefficients for oropharyngeal volume and minimum axial area in relation to polysomnographic indices.

		AHI	*p*-value	ODI	*p*-value	Lowest oxygen saturation	*p*-value	Average oxygen saturation	*p*-value
OP (mm³)	*r*	0.118	0.318	−0.086	0.471	0.010	0.933	0.180	0.128
	R^2	0.014		0.007		0.000		0.032	
Min (mm²)	*r*	0.040	0.743	−0.102	0.399	−0.019	0.878	0.196	0.104
	R^2	0.002		0.010		0.000		0.038	

OP, oropharyngeal volume; Min, minimum axial area; R^2, coefficient of determination.

Table 6. Multiple regression analysis conducted on oropharyngeal volume and minimum axial area (independent variables: age, BMI, cephalometric variables, and chin-throat length).

Variables		Coefficient	*p*-value	β	R^2
Dependent	Independent				
Oropharyngeal volume	Mandibular length (Co-Gn)	240.314	< 0.010	0.42	0.178
	Constant	−17,015.672	0.037		
Minimum axial area	Mandibular length (Co-Gn)	3.180	0.010	0.38	0.147
	Constant	−265.346	0.029		

β, standardised coefficient β; coefficient, unstandardised coefficients; R^2, coefficient of determination.

strong intraclass correlations (r = 0.991 and r = 0.999, respectively), indicating high measurement reliability.

DISCUSSION

The current study identified a slight correlation between chin-throat length and oropharyngeal volume and minimal axial area. Additionally, correlations were observed between cephalometric variables (SNB, ANB, Co-Gn, Go-Gn) and oropharyngeal volume, as well as minimal axial area. However, no correlation was observed between chin-throat length and polysomnographic indices. Co-Gn was identified as an influencing factor in the relationship between chin-throat length and oropharyngeal volume and minimum axial area.

Two-dimensional lateral cephalometry has been used to assess the dimensions of the upper airway. However, because applying 2D evaluation to 3D structures is impractical and because 2D lateral cephalometry cannot be used for volumetric measurement, this technique is not particularly effective for evaluating airway dimensions (14). Several imaging techniques can be used for upper airway assessment, namely CBCT, multidetector CT (MDCT), magnetic resonance imaging (MRI), endoscopy, and optical coherence tomography (12). CBCT has certain advantages over other imaging techniques, e.g., the radiation dose from CBCT is lower than that of MDCT. Additionally, accessibility is greater and costs of CBCT are lower than those of MRI (12). The accuracy and reliability of CBCT for upper airway assessment has been demonstrated and thus, CBCT is widely used to evaluate the upper airway (12).

The use of position-dependent upper airway dimensions has also been explored. Tsuiki et al. (15) indicated that a change in position from upright to supine influenced the dimensions of the velopharynx and oropharynx areas. Therefore, it is crucial to consider this factor. Consequently, patients in this study were scanned in a supine position using MobiiScan.

Direct clinical evaluation of facial soft tissue landmarks has also been used to predict OSA, an approach which avoids the need for radiographic examination. Early detection of OSA may be aided by clinical detection of pharyngeal airway constriction. Studies have identified a relationship between surface facial dimensions and upper airway structures in patients with OSA, implying that facial soft tissue measurement may be a valuable tool in phenotyping patients with OSA (16). However, the correlations of chin-throat length with upper airway dimensions at the oropharyngeal level and with polysomnographic indices have not been investigated previously.

The distance between the neck-throat point and soft-tissue menton is known as the chin-throat length (17). Chin-throat length is a commonly used criterion in the diagnosis and treatment planning of patients with mandibular and chin deformities who require anteroposterior correction (18). For mandibular length, a measure of 38 to 48 mm is considered normal, with Class III cases being longer and Class II cases being shorter (17). Chin-throat length differs significantly between the three skeletal sagittal types, with the chin-throat length of skeletal class II patients being substantially shorter than those of skeletal class I and III patients (9). The means and standard deviations of chin-throat length categorised by sagittal skeletal patterns were also reported in this study: 41.58 ± 5.07 mm in class I, 38.94 ± 6.29 mm in class II, and 43.72 ± 4.81 mm in class III. Related to the potential gender-related variations in chin-throat length, a 3D cephalometric investigation conducted by Wang et al. (19). disclosed significant distinctions in jaw length between males and females. Conversely, that study observed no statistically significant differences in soft tissue chin-throat length between genders. These findings reported by Wang et al. are consistent with the outcomes of the present study, where significant differences in jaw length (maxillary and mandibular length) between genders were identified; however, no statistically significant gender-based difference was discerned in chin-throat length.

The upper airway can be divided into three parts: the nasopharynx, oropharynx, and hypopharynx. In this study, our primary focus was on oropharyngeal volume because the oropharynx is the part most likely to be influenced by jaw position and the surrounding soft tissue. Changes in the spatial arrangement and dimensions of oral and pharyngeal soft tissues can occur due to shifts in the positions of the soft palate, tongue, and associated muscles (20). Individuals with Angle Class II malocclusion tend to exhibit a narrower oropharynx than those with Angle Class I or III malocclusion (21). Additionally, for predicting OSA, the association of minimum axial area with craniofacial structures has been investigated. A study reported variations in minimum axial area depending on skeletal pattern (22). With consideration for these findings, the primary objective of this study was to explore the relationship between chin-throat length and pharyngeal airway dimensions. Consequently, we selected oropharyngeal volume and minimum axial area as the key parameters for analysis.

Slight positive correlations between chin-throat length and oropharyngeal airway and minimum axial area were identified in this study. The constriction of the anatomical features of the airway does not always result in reduced respiratory performance, leading in turn to OSA, but some studies have demonstrated a correlation between oropharyngeal volume, minimum cross-sectional area, and AHI (23). Thus, the chin-throat length measurement may be able to serve as a parameter for evaluating oropharyngeal volume and minimum axial area, thereby promoting the early detection of OSA.

The current study did not identify any significant differences in oropharyngeal volume and minimum axial area between genders. This differs from research findings that have indicated a larger and longer upper airway in males compared to females (24). Nonetheless, no study has investigated the associations between chin-throat length and oropharyngeal volume and minimum axial area in men and women. When gender was considered in this study, correlations between chin-throat length and oropharyngeal volume and minimum axial area were only observed in men. Consequently, gender appears to be an influencing factor in the relationship between chin-throat length and upper airway parameters, specifically at the oropharyngeal level.

Multiple regression analysis was used to evaluate the influencing factors between chin-throat length and oropharyngeal volume and minimum axial area. The results, presented in Table 3, indicate an association between Co-Gn and oropharyngeal volume as well as minimum axial area. It is widely recognised that obesity, age (older), male gender, and craniofacial morphology influence OSA (2). Chin-throat length exhibited a positive correlation with oropharyngeal volume and minimum axial area, but other factors, particularly Co-Gn, were also found to be related to oropharyngeal volume and minimum axial area. Therefore, oropharyngeal volume and minimum axial area are influenced by a combination of factors, and Co-Gn might actually be the most significant factor affecting them.

In this study, chin-throat length was not correlated with the polysomnographic indices of AHI, lowest oxygen saturation, or average oxygen saturation. Eight patients (11.42%) were diagnosed as having OSA. Further, no correlation was observed between oropharyngeal volume, minimum axial area, and polysomnographic indices. Other studies focused on individuals with OSA have suggested that the volume of the velopharyngeal level can serve as a valuable indicator of the severity of AHI and lowest oxygen saturation (25), contrasting with the current study. However, only healthy participants between the ages of 15 and 35 with a normal BMI were included in this study. While craniofacial features may play an essential role in the pathophysiology of OSA in Asian populations (4), the syndrome was found to be occur in approximately 7% of Asian populations (26). Therefore, we suggest collecting larger samples of Asian patients with OSA to further investigate whether polysomnographic indices are related to chin-throat length, oropharyngeal volume, and minimum axial area.

In this study, chin-throat length was correlated with oropharyngeal volume and minimum axial area. Some operations, such as mandibular setback surgery, might negatively affect the upper airway (10); to reduce the risk of negative outcomes, measuring chin-throat length could serve as a valuable screening approach for upper airway assessment when planning orthodontic or orthognathic surgical treatment.

This study makes certain contributions to the literature, but a key limitation should be mentioned. CBCT was performed while the patients were awake. This is problematic because, as various studies using 2D lateral cephalometry and CBCT have demonstrated, the position of patients affects their airway dimensions (27). A static supine position does not accurately depict the moving and changing positions that occur during sleep (28), and whether the patient is asleep or awake has a crucial influence on airway dimensions (28). Therefore, CBCT imaging performed with patients in the supine position is not ideal because it does not allow for accurate simulation of sleeping conditions.

CONCLUSIONS

A slight positive correlation was identified between chin-throat length and oropharyngeal volume and minimum axial area. However, this correlation was only observed among men. Additionally, SNB, ANB, Co-Gn, and Go-Gn demonstrated correlations with both oropharyngeal volume and minimum axial area. The crucial variables influencing the relationship between chin-throat length and oropharyngeal volume and minimum axial area may include mandibular length. The present study found no correlation between chin-throat length and polysomnographic indices.

CONFLICTS OF INTEREST

The authors have no conflicts of interest to report.

ADDITIONAL INFORMATION
Author contribution

Conceptualization, W.T., N.S., W.P., D.J., T.S., T.S., K.T.; Methodology, W.T., N.S., D.J., T.S., K.K., K.T.; Software, N.S., K.T.; Validation, W.T., N.S., W.P., T.S., K.T.; Formal analysis, W.T., T.S.; Investigation, W.T., N.S., K.K., K.T.; Resources, N.S., D.J., K.T., Data curation, T.S.; Writing—original draft preparation, W.T.; Writing—review and editing, N.S., D.J., K.K., P.K., W.T., visualization, K.T.; Supervision, K.T.; Project administration, K.T.All authors have read and agreed to the published version of the manuscript.

Institutional review board statement

This study was approved by the Human Experimentation Committee of Chiang Mai University's Faculty of Dentistry (No. 68/2563).

Informed consent statement

Informed consent was obtained from all subjects involved in the study.

Data availability statement

All data are available upon request.

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