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ORIGINAL RESEARCH

THE INFLUENCE OF MOUTH BREATHING ON MAXILLARY ARCH WIDTHS AND FACIAL DIMENSIONS (AN ANALYSIS USING A SPECIAL ARCH WIDTH INDEX)

Ahmed Ayoob Taha[1], Brwa Mahdi Khoshnaw[1]

[1]Department of Orthodontics, College of Dentistry, Hawler Medical University, Erbil, Iraq

Corresponding Author: Dr. Brwa Mahdi Khoshnaw BDS, MSc, PhD (Orthodontics) Department of Orthodontics, College of Dentistry, Hawler Medical University, Iraq, Kurdistan Region Erbil 60M. Street Fax: +964662228795 P.O. Box: 178 Email: brwakhoshnaw@hmu.edu.krd Phone: +964 750 486 4444

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ABSTRACT

Background: Mouth breathing, commonly resulting from nasal obstructions, significantly affects craniofacial development by disrupting the balance of oral and facial muscles. This leads to altered posture, narrower maxillary arches, and increased vertical facial dimensions.

Aims and Objectives: The present study aimed to compare maxillary arch widths and cephalometric characteristics between mouth breathers and nasal breathers.

Methods and Materials: A total of 152 participants aged 15–45 years were examined at the College of Dentistry, Hawler Medical University. Breathing tests (lip seal, mirror, water retention), 3D intraoral scans, cephalometric radiographs, and digital arch measurements using Meshlab software.

Results: showed that mouth breathers had significantly reduced arch widths (in first and second premolars, first molars area) and higher mandibular plane angles, anterior facial heights, and gonial angles compared to nasal breathers. Arch ratios were also lower among mouth breathers, indicating maxillary constriction. These craniofacial alterations were generally consistent across age groups, although anterior facial height increased slightly with age. Gender differences were minimal, with some variations observed in males.

The study highlights the importance of early identification and intervention for mouth breathers to prevent long-term orthodontic and skeletal complications. Dental professionals should be aware of the structural implications of mouth breathing to guide timely diagnosis and treatment planning.

Conclusion: In conclusion, the mouth breathing is accompanied with high risk of malocclusion. Mouth breathing is a significant risk factor for reducing maxillary arch width and increasing cephalometric measures. These maxillary and cephalometric changes are not affected by age, while somewhat affected by gender.

Keywords: Mouth breathing, Maxillary arch width, Facial dimensions, Digital diagnostic casts, Craniofacial development, Mandibular plane angle, Anterior facial height

INTRODUCTION

The oral cavity supports key functions like breathing, feeding, and speech, all of which work in balance. Disruption in any of these can negatively impact craniofacial growth and development.(1)

Mouth breathing is the act of inhaling and exhaling through the mouth, often due to nasal obstruction. It affects 5–75% of children and typically occurs when nasal airflow is restricted. (2) In normal breathing, children keep lips closed with the tongue resting against the palate, maintaining muscle balance essential for proper arch development. Mouth breathing disrupts this balance, reducing tongue pressure and leading to craniofacial changes. [3] This affects the growth of the maxilla, mandible, and teeth, leading to skeletal and dental malocclusions. [4] Mouth breathing, whether obstructive or habitual, is linked to increased vertical facial growth from mandibular rotation. However, the causal relationship remains debated, as mouth breathing may also result from naturally long facial structures. [5] Many studies on dentofacial development and airway size excluded mouth-breathers, leaving the link between airway dimensions, breathing mode, and malocclusion unclear. [6] Mouth-breathing children often show adenoid faces, featuring lip incompetence, a retropositioned hyoid bone, narrow upper dental arch, retruded lower incisors, longer face height, V-shaped maxillary arch, steeper mandibular plane, and a backward-rotated mandible compared to healthy children. [7] Faria PT et al. found that mouth breathing is linked to maxillo-mandibular retrusion and increased SNGoGn (Sella-Nasion to Gonion-Gnathion) and NSGn (Nasion-Sella to Gnathion) angles compared to nasal breathers. [8] Mouth breathing is a common harmful habit in children and a symptom of sleep-disordered breathing, affecting 11–56% of them. [9-12] Like other bad habits such as abnormal biting, tongue use, chewing, and sleeping patterns. [13] Mouth breathing may resolve with age or harm dental and facial development in children. [14] If not treated early, persistent mouth breathing can harm both dentofacial development and overall health in children. Early screening and orthodontic intervention are essential to prevent these effects. [15]

2. MATERIAL AND METHODS

Sample Selection:

The study will be conducted at the College of Dentistry consultation clinics, Hawler Medical University, from August 2024 to August 2025. It includes a total of 152 participants, 72 mouthbreathing patients and 80 controlled group, aged 15-45. Ethical approval (HMUD2425152) was obtained from the Hawler Medical University Ethics Committee, and data confidentiality will be maintained.

Chart 1. Adopted criteria for sample selection.

Inclusion criteria	Exclusion criteria
• Permanent Dentition • No orthodontic or maxillary orthopedic treatment • Presence of premolars and molars • Absence of any provisional crowns	• Previous orthodontic treatment done or in progress • Absence of any of premolars and molar • Presence of any provisional crowns • Presence of cleft palate and any syndrome • Cases couldn't be classified as mouth breather or nasal breather,and borderline cases

How Mouth Breathers Diagnosed:

A combination of case history, clinical exams, and clinical breathing tests is used:

- **History & symptoms:** Ask about habitual mouth breathing, dry mouth/lips upon waking, snoring, or audible breathing at night.
- **Clinical observation**: Look for intraoral/extraoral signs (e.g., drooling posture, reduced lip seal) and test patient reaction when nostrils are blocked. Good alar control suggests nasal breathing.
- **Breathing tests** (most common in mouth-breathing protocols):
  - **Lip-seal test:** Assess ability to keep lips sealed. Figure 1.
  - **Mirror test:** Hold a mirror under nose and mouth. Fog on oral side indicates mouth breathing. Figure 2.
  - **Water retention test (Massler's):** Fill mouth with water — mouth breathers struggle to retain it. Figure 3.

Figure. 1. Lip sealing test.

Figure. 2. Mirror Test.

Figure. 3. Water Holding Test.

Intra oral scans: Taken with an APPLEDENTAL 3D intra oral scanner.

Measuring Method

- **Arch length:** from central-incisors contact point to a line across distal surfaces of the second molars. Figure 4.
- **Arch width:** measured at the centers of the second molars.
- **First premolar width:** straight-line between first premolar centers. Figure 6.
- **Second premolar width:** straight-line between second premolar centers. Figure 6.
- **First molar width:** straight-line between first molar centers. Figure 6.

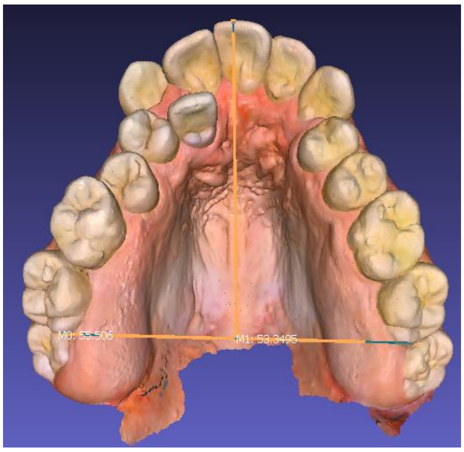


Figure 4. Length of the maxillary arch for a mouth breather patient.

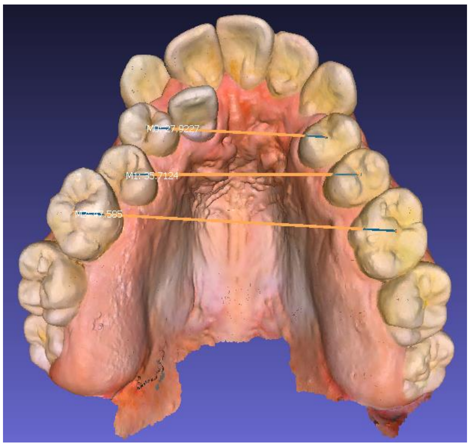
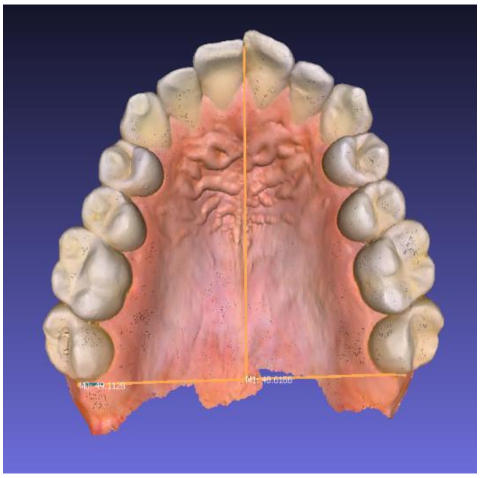


Figure 5. Widths of maxillary arch in first, second premolar and first molar region for a mouth breather patient.



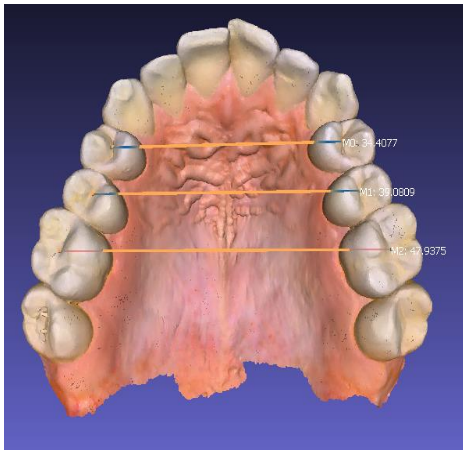


Figure 6. length of maxillary arch for a nasal breather patient.

Figure 7. Widths of maxillary arch in first, second premolar and first molar region for a nasal breather patient.

Radiographic Method

- **Setup & Positioning**

Radiographs (lateral cephalometric) were taken at Hawler Medical University in natural head position, with cephalostat ear rods inserted and nose rest lightly supporting the nasion; pupils centered to ensure standard orientation. Figure 8.

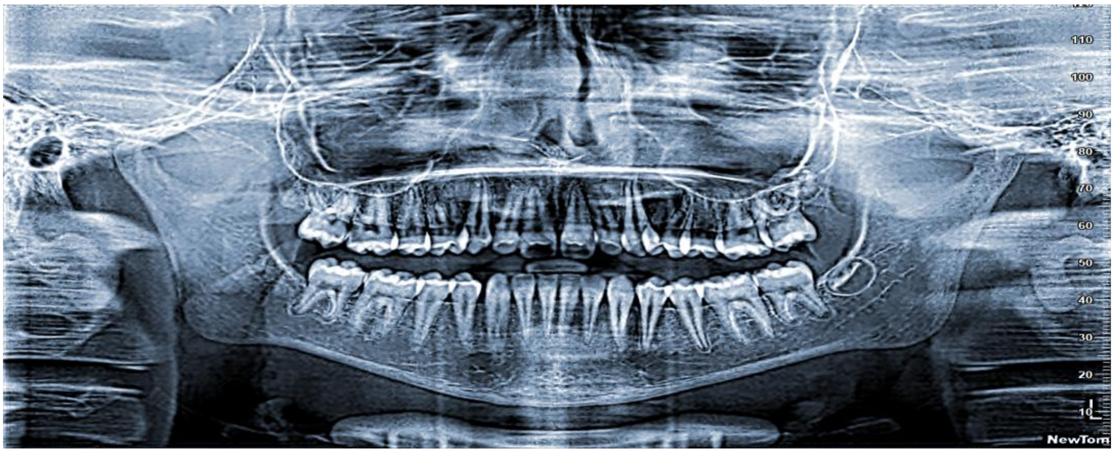
- **Patient Instructions**

Patients stood upright with teeth in habitual occlusion and relaxed lips, swallowing prior to exposure to prevent nasopharyngeal misrepresentation. Figure 9.

Figure 8 Radiographs (frontal cephalometric)

Figure 9 Radiographs (lateral cephalometric)

- **Radiation Protection & Equipment**
  Lead aprons were used, and X-rays were taken using the NewTom Giano unit; beam collimation and positioning minimized exposure.



- **Figure 10. OPG** Radiographic Image reveals septal bone deviation.

- **Analysis**
  Cephalometric measurements followed Jarabak protocols using standard anatomical landmarks and linear/angle analyses. Figure 11. & Figure 12.

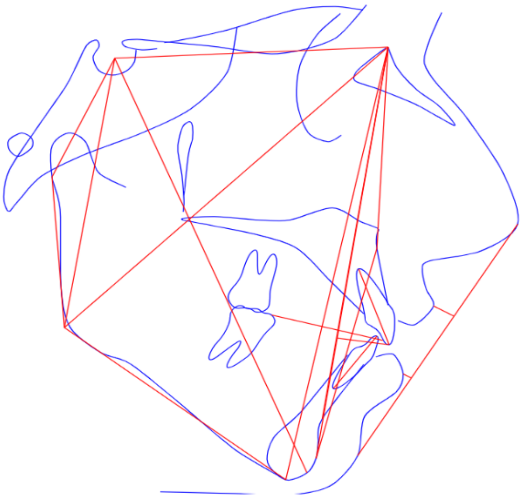


Figure11. Mouth breather Cephalometry

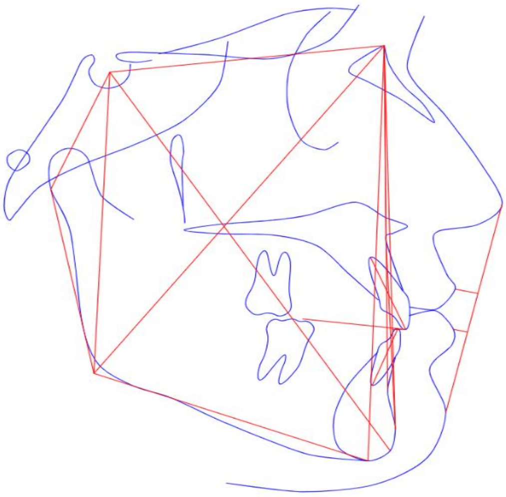


Figure 12. Nasal Breather Cephalometry

3. RESULTS

This study included one hundred and fifty-two participants divided into two groups; nasal breather (80 participants) and mouth breather (72 participants). No significant differences were observed between both study groups regarding age and gender (p>0.05). Table 1

Table 1. Demographic characteristics of participants.

Variable	Study groups				P value
	Nasal breather		Mouth breather		
	No.	%	No.	%	
Age					0.29^{NS}
<20 years	30	37.5	34	47.2	
20-29 years	39	48.8	28	38.9	
30-39 years	9	11.3	10	13.9	
≥40 years	2	2.5	0	-	
Gender					0.6^{NS}
Male	39	48.8	38	52.8	
Female	41	51.2	34	47.2	

Means of FPAW, SPAW and FMAW were significantly lower among mouth breather than nasal breather participants (p≤0.05). Mean of mid-line arch length was not significantly different between two study groups, however, means of FP index arch, SP index arch and FM index arch ratios were significantly lower among mouth breather than nasal breather participants (p≤0.05). Table 2 and Figures 13,14.

Table 2. Maxillary arch width (mm) and facial dimension measures in regard to study groups.

Measures	Study groups		Mean difference	P value
	Nasal breather Mean±SD	Mouth breather Mean±SD		
FPAW	36.1 ±2.4	33.4±3.1	2.6	**<0.001**[S]
SPAW	39.8 ±3	38.2±3.1	1.54	**0.002**[S]
FMAW	45±3.7	43.9±3.5	1.16	**0.05**[S]
Mid-line Arch length	49.3±2.3	49.2±3.5	0.12	0.79[NS]
FP Index Arch Ratio	0.731±0.043	0.68±0.063	5.1	**<0.001**[S]
SP Index Arch Ratio	0.8±0.055	0.778±0.055	2.8	**0.002**[S]
FM Index Arch Ratio	0.913±0.062	0.893±0.063	1.9	**0.05**[S]

S=Significant, NS=Not significant.

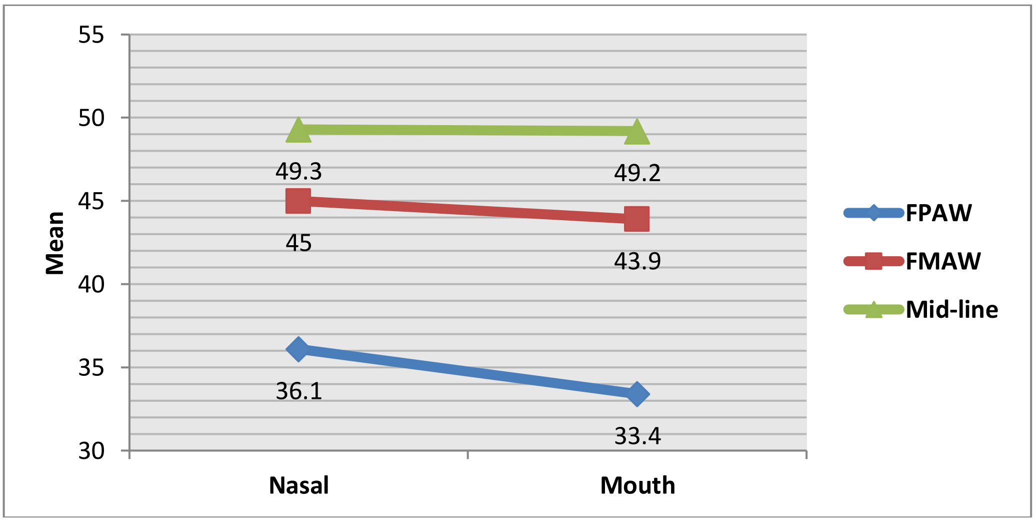


Figure 13. Facial measures distribution in regard to study groups.

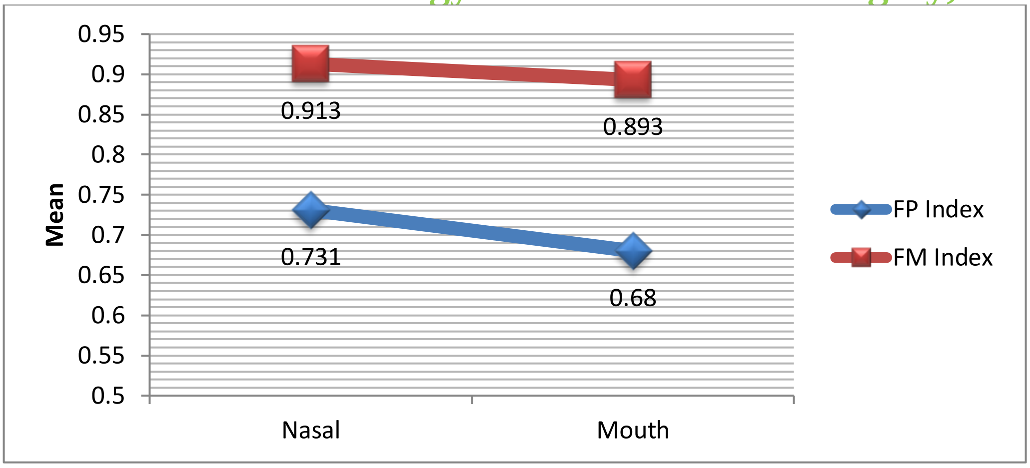


Figure 14. Facial measures indices distribution in regard to study groups.

On other hand, means of Bjork sum, AFH and Gonial angle were significantly higher among mouth breather than nasal breather participants ($p \leq 0.05$). Mean of Jarabak was significantly lower among mouth breather than nasal breather participants ($p<0.001$). Table 3

Table 3. Cephalometric measures in regard to facial height dimension.

Measures	Study groups		Mean difference	P value
	Nasal breather Mean±SD	Mouth breather Mean±SD		
Bjork sum	389.2±4.6	397.4±6.3	-8.2	**<0.001**^{S}
AFH	117.6±7.7	122.6±11.7	-4.9	**0.002**^{S}
Jarabak	69±4.3	63.5±4.9	5.4	**<0.001**^{S}
Gonial Angle	118.6±5.8	124.8±7.4	-6.19	**<0.001**^{S}

For participants<20 years age, all studied measure were significantly different between both study groups ($p \leq 0.05$), except for FMAW, mid-line arch length and AFH ($p>0.05$). For participants 20-29 years age, all studied measure were significantly different between both study groups ($p \leq 0.05$), except for FMAW, mid-line arch length, SP index arch ratio and FM index arch ratio ($p>0.05$). For participants 30-39 years age, all studied measure were not significantly different between both study groups ($p>0.05$), except for FPAW that was significantly lower among mouth breather than nasal breather participants ($p=0.05$). Table 4

Table 4. Significance levels of maxillary arch width and facial dimension measures in regard to study groups for different age groups.

Variable	Age groups		
	<20 years P value	20-29 years P value	30-39 years P value
FPAW	<0.001^{S}	<0.001^{S}	0.05^{S}
SPAW	0.04^{S}	0.03^{S}	0.6^{NS}
FMAW	0.15^{NS}	0.12^{NS}	0.7^{NS}
Mid-line Arch length	0.6^{NS}	0.4^{NS}	0.9^{NS}
FP Index Arch Ratio	<0.001^{S}	0.04^{S}	0.06^{NS}

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SP Index Arch Ratio	0.005S	0.12NS	0.7NS
FM Index Arch Ratio	0.04S	0.3NS	0.6NS
Bjork sum	<0.001S	<0.001S	0.2NS
AFH	0.9NS	<0.001S	0.7NS
Jarabak	<0.001S	<0.001S	0.19NS
Gonial Angle	0.005S	<0.001S	0.12NS

S=Significant, NS=Not significant.

For male participants, all studied measure were significantly different between both study groups (p≤0.05), except for FMAW, mid-line arch length and FM index ratio (p>0.05). For female participants, all studied measure were significantly different between both study groups (p≤0.05), except mid-line arch length and AFH (p>0.05). Table 5

Table 5. Significance levels of maxillary arch width and facial dimension measures in regard to study groups for different genders.

Variable	Gender	
	Male	Female
	P value	P value
FPAW	<0.001S	<0.001S
SPAW	0.04S	0.01S
FMAW	0.29NS	0.05S
Mid-line Arch length	0.9NS	0.8NS
FP Index Arch Ratio	<0.001S	<0.001S
SP Index Arch Ratio	0.03S	0.01S
FM Index Arch Ratio	0.2NS	0.05S
Bjork sum	<0.001S	<0.001S
AFH	0.001S	0.2NS
Jarabak	<0.001S	<0.001S
Gonial Angle	<0.001S	0.007S

S=Significant, NS=Not significant.

All studied measures of mouth breather participants were not significantly different in regard to age groups (p>0.05), except for AFH that was significantly increased with increase of age (p=0.01). Table 6

Table 6. Maxillary arch width and facial dimension measures of mouth breather participants in regard to age groups.

Variable	Age groups			P value
	<20 years	20-29 years	30-39 years	
	Mean±SD	Mean±SD	Mean±SD	
FPAW	33.1±2.3	33.4±4.1	34.2±3.1	0.6 NS

SPAW	38±2.9	38.2±3.5	39.1±2.5	0.6 NS
FMAW	43.5±3.3	43.9±3.7	45±3.9	0.5 NS
Mid-line Arch length	49.3±3.7	49±3	49.3±4.3	0.9 NS
FP Index Arch Ratio	0.674±0.039	0.683±0.086	0.697±0.051	0.5 NS
SP Index Arch Ratio	0.772±0.045	0.78±0.065	0.796±0.058	0.4 NS
FM Index Arch Ratio	0.884±0.057	0.896±0.069	0.915±0.069	0.39 NS
Bjork sum	396.8±5.1	398.8±6.3	395.4±9.1	0.27 NS
AFH	118.6±12.3	127.3±9.7	129.1±10.4	**0.01** S
Jarabak	64±4.6	62.7±4.8	64.3±6.6	0.5 NS
Gonial Angle	124.4±6.9	125.4±6.4	124.7±11.3	0.88 NS

S=Significant, NS=Not significant.

All studied measures of mouth breather participants were not significantly different between male and female participants ($p>0.05$), except for FM index ratio, AFH and Gonial angle that were significantly increased among male gender participants ($p\leq0.05$). Table 7

Table 7. Maxillary arch width and facial dimension measures of mouth breather participants in regard to age groups.

Variable	Gender		P value
	Male	Female	
	Mean±SD	Mean±SD	
FPAW	33.7±3.2	33±2.9	0.3 NS
SPAW	38.5±2.9	37.9±3	0.4 NS
FMAW	44.5±4	43.2±2.8	0.1 NS
Mid-line Arch length	49.1±3.1	49.3±3.9	0.8 NS
FP Index Arch Ratio	0.688±0.057	0.672±0.068	0.3 NS
SP Index Arch Ratio	0.784±0.056	0.772±0.055	0.3 NS
FM Index Arch Ratio	0.906±0.067	0.878±0.055	**0.05** S
Bjork sum	398.2±6.4	396.5±6.1	0.2 NS
AFH	126.5±10	118.3±12	**0.002** S
Jarabak	63.2±5.1	63.9±4.7	0.5 NS
Gonial Angle	127±7.5	122.4±6.5	**0.008** S

S=Significant, NS=Not significant.

4. DISCUSSION

Mouth breathing is linked to various anatomical and medical conditions; however, this issue is still controversial. [16] Although mouth breathing is common among adult population, the interest of authors has been directed towards children. [17, 18]

In current study, the included adult participants were not significantly different in age and gender between nasal and mouth breathing. Consistently, previous study revealed no significant difference in age and gender between Iraqi adults with nasal breathers and mouth breathers. [19] Recent single-center prospective study conducted in Taiwan found no effect of age on patency of nasal airways of adults, while females have wider nasal airways than males. [20]

Present study showed that means of first premolar arch width, second premolar arch width and first molar arch width were significantly lower among mouth breather than nasal breather participants ($p \leq 0.05$). These findings are in agreement with results of different literatures implemented in Italy and Spain which all documented that oral breathing was accompanied in reduction of dental arch among both children and adults. [21, 22] Additionally, Harari et al [23] study reported that mouth breathing from childhood leads to reduction of mandibular and maxillary growth. Our study showed that means of FP index arch, SP index arch and FM index arch ratios were significantly lower among mouth breather than nasal breather participants ($p \leq 0.05$). This finding coincides with results of previous Brazilian study which found that mouth breathers had narrower hard palate at level of first and second premolars. [24] Oral breathing compensated the nasal breathing which causes various changes in tongue, muscle physiology and cranial placement. [25, 26] These changes affect maxillary and mandibular development and lead to skeletal and dental malocclusions. [27]

Current study found that means of Bjork sum, AFH and Gonial angle were significantly higher among mouth breather than nasal breather participants ($p \leq 0.05$). Recent Indian study showed that mouth breathing led to increase in facial height, gonial angle, and mandibular plane angle. [28] In Kurdish population this study reveals that the cephalometric measurments shows Jarabak ratio, anterior and posterior facial height values are increased. [29] In Iraq, previous study revealed that mouth breathing caused increase in SNA angle with obvious proclination in upper incisors and reduction of upper arch. [30] Faria PT et al. found that mouth breathing is linked to maxillo-mandibular retrusion and increased SNGoGn (Sella-Nasion to Gonion-Gnathion) and NSGn (Nasion-Sella to Gnathion) angles compared to nasal breathers. [8]

In present study, the effect of mouth breathing on facial dimensions was not affected by age of adults except for some measures. This finding is parallel to results of recent review study implemented in China which documented no effect of age differences on relationship between moth breathing and dentofacial pattern an adult population. [31] In our study, the effect of mouth breathing on facial dimensions was not affected by gender difference of adults except for some measures. This finding is inconsistent with results of recent Chinese study which showed a significant effect of gender on facial developmental abnormalities related to mouth breathing. [32] This inconsistency might be related to differences in facial development between different races and variances related to study design and sample size between different studies.

This study found that all studied measures of mouth breather participants were not significantly different in regard to age groups ($p>0.05$), except for AFH that was significantly increased with increase of age ($p=0.01$). This finding is close to results of previous cross sectional Indian study which reported no effect of age on facial development of mouth breathers. In our study, all studied measures of mouth breather participants were not significantly different between male and female participants ($p>0.05$), except for FM index ratio, AFH and Gonial angle that were significantly increased among male gender participants ($p \leq 0.05$). These findings are in agreement with results of previous Iraqi study which reported significant differences in facial measures of mouth breathers between male and female genders.

5. CONCLUSION

In conclusion, the mouth breathing is accompanied with high risk of malocclusion. Mouth breathing is a significant risk factor for reducing maxillary arch width and increasing cephalometric measures. These maxillary and cephalometric changes are not affected by age, while somewhat affected by gender.

DECLARATIONS

Ethical approval and consent to participate

Ethical permission was granted by the Medical Ethics Committee of the Faculty of Dentistry, Sana'a University (Ref. No.: 703; Date: 2/8/2024). All patient identifiers were anonymized for confidentiality *with the ethical principles outlined in the Declaration of Helsinki*.

Availability of data and material

All data generated or analyzed during this study are included in the published article.

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