

### The relationship between maxillary and mandibular lengths of ethnic Bataks of chronological age 9–15 years

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#### ABSTRACT

**Background:** Maxillary and mandibular growth have an important role in determining diagnosis and treatment plans. Knowledge of the growth of the maxilla and mandible becomes very important in designing a proper treatment plan and knowing the mean maxillary and mandibular lengths from the ages of 9–15 means malocclusion can be treated at the appropriate age. **Purpose:** The aim of this study was to determine the relationship between 9–15-year-old males and females and the length of the maxilla and mandible. **Methods:** This study used a cross-sectional design. The subjects consisted of 35 male and 45 females aged 9–15 years and 80 cephalometric radiograms were collected using a purposive sampling method from Universitas Sumatera Utara (USU) Oral and Dental Hospital based on inclusion and exclusion criteria. Data were collected by tracing the lateral cephalogram, the maxillary length and mandible lengths being measured on the cephalogram based on the McNamara method through a computer program, CorelDRAW. Pearson's correlation coefficient was used for statistical analysis. **Results:** The average maxillary length for 9–15-year-olds was  $96.35 \pm 7.56$  mm. The mean mandibular length for 9–15-year-olds was  $122.29 \pm 10.43$  mm. Based on assessment and result, using the Pearson correlation coefficient test between maxillary length and mandibular length and chronological age, a maxillary length of  $p=0.003$  and mandibular length of  $p=0.00$  were obtained. **Conclusion:** There was a significant positive relationship between chronological age and maxillary length and mandibular length in 9–15-year-olds of Batak ethnicity.

**Keywords:** chronological age of 9-15 years; mandibular; maxillary

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#### INTRODUCTION

The process of growth and development of the craniofacial area is one area of knowledge that must be possessed by dentists, especially orthodontists. This knowledge has an important role in establishing a diagnosis and treatment plan, especially in cases that require modification of facial bones in patients, such as the maxilla and mandible.<sup>1,2</sup> Malocclusion is a dental and oral problem that ranks third, after caries and periodontal disease, with a rate of prevalence of 80% of the population of Indonesia.<sup>3</sup> Treatment of malocclusion needs to be done early in order to achieve maximum treatment results, as it have not yet reached maturity. Bone growth in the craniofacial area is more significant before reaching maturity as this bone growth will provide space for the malocclusion repair process.

Research by Enikawati, et al.<sup>4</sup> displays results indicating that the greatest increase in maxillary length in males occurs at 14–15 years of age. The greatest increase in maxillary and mandibular length in girls, and mandibular length in boys, occurs between the ages of 13 and 14 years.<sup>4</sup> This period of accelerated growth is called adolescence, or pubertal growth spurt, and always shows variations in growth rates, onset, intensity and duration in each child.<sup>2,5</sup> Research conducted by Hsiao, et al.<sup>6</sup> over the range of 7–12 year-old school children shows results indicating that the maxillary length experienced significant growth in Group 3, namely aged 11–12-years-old, compared to the age group of 7–10 years; also, in respect to mandibular length, there was a significant difference with age.

Various studies were conducted to assess the relationship between peak growth period and indicators of child development, such as chronological age, physiological

age with height and weight, dental age, skeletal maturation and secondary sex characteristics.<sup>2</sup> Djoeana, et al.<sup>7</sup> argue that different racial groups will display different patterns of craniofacial growth. Therefore, every ethnic group in Indonesia has different maxillary and mandibular growth from each other.<sup>7</sup> Most of Indonesia's population is dominated by ethnic Malays, who are then divided into Proto-Malays and Deutro-Malays. The Batak ethnic group is part of the Proto-Malay ethnic group that occupies the island of Sumatra and dominates North Sumatra.<sup>8</sup> Research on maxillary and mandibular length in ethnic Bataks has not been well researched and is still limited, especially in Medan City. Based on statistics from the Sumatera Utara Agency (BPS), the Bataks are the largest ethnic group in North Sumatra with a percentage of 44.75% of the total population there.<sup>9</sup> So we chose and were interested in conducting a study of maxillary and mandibular length in children aged 9–15 years of Batak ethnicity, which is the largest ethnic in North Sumatra.

## MATERIAL AND METHODS

This descriptive cross-sectional study was carried out at the Universitas Sumatera Utara (USU) Oral and Dental Hospital, Medan, Indonesia. The research sample consisted of 80 lateral cephalograms consisting of 35 boys and 45 girls aged 9–15 years Batak ethnicity, collected using a purposive sampling method based on the inclusion and exclusion criteria. The inclusion criteria were lateral cephalograms of patients aged 9–15 years, Skeletal Class I (patients who have not received orthodontic treatment), and lateral cephalograms with good quality. The exclusion criteria included a history of craniofacial trauma and fractures, incomplete patient medical records and craniofacial disease, and symptoms or anomalies.

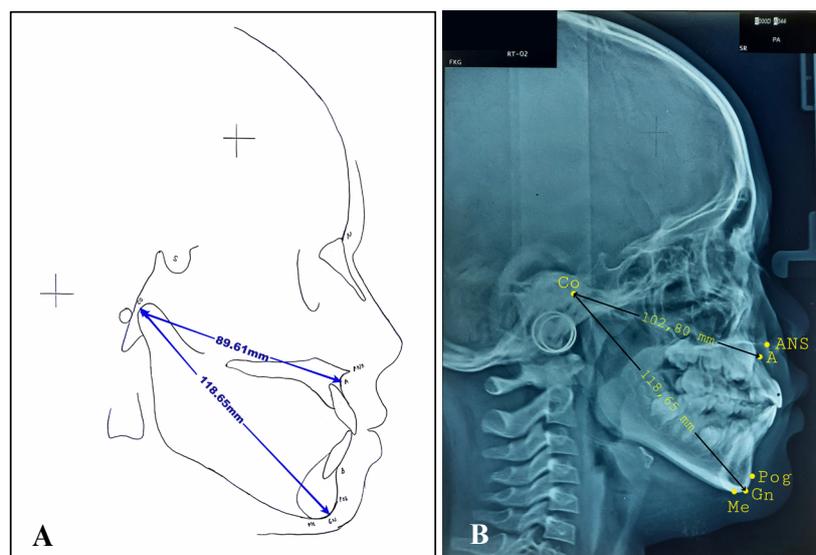
This study had permission from the Research Ethics Committee of Universitas Sumatera Utara (Number 132/KEP/USU/2021).

After collecting the samples of cephalograms that matched the inclusion criteria, then tracing manually using a pencil, ruler, tape, tracing paper, and a tracing box, the cephalometric anatomical landmarks at the anterior nasal spine (ANS) – spinous process of the maxilla forming the most anterior projection of the floor of the nasal cavity – were marked points: A (the deepest point on the curved, bony outline between the ANS and prosthion [Pr]), Pog (the most prominent point on the anterior aspect of symphysis of the mandible), Me (the most inferior point on the symphysis of the mandible), Gn (the intersection of Facial Plane and Mandibular Plane), Co (the highest point of superior curvature of the condyle of the mandible).<sup>10</sup>

Tracing was done in a systemic manner. The major references, landmarks, and line measurement of the McNamara analysis were traced and are shown in Figures 1A and 1B.

An analysis of the growth length of the maxillary and mandible was carried out by determining the points on the cephalogram using CorelDRAW X7 (Canada) on a computer. After tracing and defining landmarks, the paper is then scanned and transferred to a computer by using a printer (Figure 1A). Entering the scanned file into the CorelDRAW software application then gives the patient's name and age. The maxillary length was measured using the McNamara method with the CorelDRAW software, with the help of a mouse, by the line from the reference point of the condyle to point A (drawing a line from point A to the point of the condyle), and the length of the mandible was measured by the Co-Gn reference line from condyle point to gnathion (Figure 1B).<sup>11</sup>

The data obtained was then processed and this data fed to the computer and analysed using statistical testing.



**Figure 1.** The results of tracing McNamara's measurement using the 'parallel dimension tool' in CorelDRAW X7 (A). Cephalometric tracing of McNamara's measurement (B).

After all the data had been collected, to prove the data distribution is normal the Kolmogorov-Smirnov normality test was performed. The Pearson correlation coefficient ( $r$ ) test was performed to assess the correlation of maxillary and mandibular lengths associated with chronological age 9–15 years of different sexes.

## RESULTS

Based on the data of Table 1, it could be seen that the mean maxillary length of males was highest at the age of 15 years with a length of  $111.79 \pm 7.97$  mm and the mean maxillary length of females was highest at the age of 15 years with a length of  $101.98 \pm 2.30$  mm. The lowest mean maxillary length for males was at age 12 with a length of  $91.97 \pm 8.14$  mm and the lowest mean maxillary length for females was at age 13 years with a length of  $91.65 \pm 7.06$  mm.

Table 1 shows the average maxillary length of 9–15-year-olds from the sample group of the USU Oral and Dental Hospital. The results of this study are in line with the results of the study by Fouda, et al.<sup>10</sup> of 60 male and female Egyptian patients, where the results determined that the mean maxillary length of males was  $76.80 \pm 5.15$ , higher than that of females, which was  $73.55 \pm 5.90$  mm, and the study by Enikawati, et al.<sup>4</sup> of 10–16-year-olds using a different maxillary length measurement point (namely from the ANS-PNS points), showing the mean maxillary length for males was  $45.91 \pm 3.34$  mm, higher than that for females, which was  $43.96 \pm 3.24$  mm.

Based on Table 2 data, it can be seen that the highest mean mandibular length for males was at the age of 15 years with a length of  $146.93 \pm 10.76$  mm and the highest mean mandibular length for females was at the age of 15 years with a length of  $127.29 \pm 2.87$  mm. The lowest mean

mandibular length for males was at the age of 12 years with a length of  $115.49 \pm 9.85$  mm and the lowest mean mandibular length for females was at the age of 9 years with a length of  $113.01 \pm 3.04$  mm.

Table 2 shows the average length of the mandible at the age of 9–15-year-olds from the sample group of the USU Oral and Dental Hospital. The results of this study are in line with the results of the study by Fouda, et al.<sup>10</sup> of 60 male and female Egyptian patients, where the results determined that the mean mandibular length for males was  $100.15 \pm 7.14$  mm, which was higher than in females, which was  $96.18 \pm 6.94$  mm and the study by Enikawati, et al.<sup>4</sup> using different mandibular length measurement points (namely the measurement between the gonion and menton points), where the mean mandibular length for males was  $62.01 \pm 3.24$  mm, which was higher than that for females, being  $60.52 \pm 4.20$  mm.

Table 3 shows the results of the correlation test between chronological age and maxillary length ( $r$  count  $>$   $r$  table), obtaining the value of  $r = 0.329$  and an  $r$  table value of 0.220. It can be concluded that chronological age is positively correlated with maxillary length, where a positive correlation value indicates a directional relationship between chronological age and maxillary length. Mandibular correlation value obtained  $r = 0.370$ , which means that chronological age is positively correlated with the mandible with a directional relationship between chronological age and mandibular length. There is an increase in maxillary and mandibular length growth at different ages.

The level of correlation is included in the category of sufficient correlation because it is in the class interval 0.25–0.5. The significance value was obtained ( $p < 0.05$ ), which means that the length of the maxilla and mandible has a correlation with chronological age.

**Table 1.** The mean maxillary length from 9–15-year-olds in the sample group from the USU Oral and Dental Hospital

Age (Years)	Males		Females	
	n	Mean $\pm$ SD (mm)	n	Mean $\pm$ SD (mm)
9	5	95.89 $\pm$ 7.64	6	91.71 $\pm$ 1.28
10	11	93.54 $\pm$ 8.88	10	97.68 $\pm$ 7.64
11	9	96.68 $\pm$ 6.14	14	94.01 $\pm$ 5.01
12	3	91.97 $\pm$ 8.14	6	97.97 $\pm$ 4.80
13	2	101.88 $\pm$ 6.56	4	91.65 $\pm$ 7.06
14	2	109.04 $\pm$ 9.03	2	96.46 $\pm$ 3.20
15	3	111.79 $\pm$ 7.97	3	101.98 $\pm$ 2.30
Total	35	97.47 $\pm$ 9.25	45	95.48 $\pm$ 5.90

**Table 2.** The mean mandibular lengths at the age of 9–15-year-olds in the sample group from the USU Oral and Dental Hospital

Age (Years)	Males		Females	
	n	Mean $\pm$ SD (mm)	n	Mean $\pm$ SD (mm)
9	5	125.03 $\pm$ 8.89	6	113.01 $\pm$ 3.04
10	11	118.48 $\pm$ 8.65	10	127.04 $\pm$ 9.94
11	9	123.51 $\pm$ 7.97	14	117.51 $\pm$ 7.73
12	3	115.49 $\pm$ 9.85	6	119.25 $\pm$ 7.60
13	2	124.31 $\pm$ 4.07	4	121.72 $\pm$ 10.83
14	2	141.58 $\pm$ 9.71	2	122.18 $\pm$ 2.02
15	3	146.93 $\pm$ 10.76	3	127.29 $\pm$ 2.87
Total	35	124.54 $\pm$ 11.9	45	120.49 $\pm$ 8.82

**Table 3.** Results of the r-test (correlation) of maxillary and mandibular lengths associated with chronological age

Age (Years)	Maxillary length		Mandibular length	
	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>
9-15	0.329	0.003*	0.370	0.001*

\*Significant  $p < 0.05$ 

r test description:

0: there is no correlation between the two variables

0.01 – 0.25: weak correlation

0.26 – 0.5: sufficient correlation

0.51 – 0.75: strong correlation

0.76 – 0.99: very strong correlation

## DISCUSSION

Knowledge of the growth of the skull and jaw, especially the maxilla and mandible, is very important during adolescence when the growth spurt occurs.<sup>1</sup> According to Evälahti's<sup>11</sup> study, the male mandibles begin to grow more rapidly, with a total average increase of 36.5 mm, between the ages of 4 and 25, while in females at the same age the average increase was 28.2 mm. Peak growth is a period of dynamic development characterised by rapid changes in size, shape, and body, with sexual dimorphism.<sup>12</sup>

From this study we found that the maxillary length growth of ethnic Bataks was higher in males than females. This is in accordance to a previous study by Laowansiri, et al.<sup>13</sup> that states a significant difference in the maxillary size of males and females where the maxillary size of males is larger than that of females. Differences in growth that occur in males and females are caused by either natural factors or disruptive factors. Natural factors include genetic variation, and pressure/the biomechanical theory and disruptive factors include malnutrition, hormones, and habits.<sup>14</sup> A natural factor that can control the growth of the maxilla and mandible is the presence of genetic variation. Based on the biomechanical theory, the main factor in controlling bone growth is pressure. Mechanical stress represents one of the many signals involved in the activation of osteogenic connective tissue. However, what regulates the complex balance of genic activity among the various cells and tissues that play a role is not known.<sup>15,16</sup>

Also, from this study we also found that the mandibular length growth was higher in males than females. The mandible in males is 9.3 mm longer on average than in females.<sup>11</sup> There are differences in men and women because the pattern of bone remodelling is not the same and can be influenced by genes, hormones, and the environment.<sup>12,13,15</sup> Other types of factors that affect the growth of the maxilla and mandible are disruptive factors, one of which is malnutrition.<sup>15,16</sup> Poor nutrition during childhood growth can affect the normal pattern of craniofacial development. Nutritional deficiencies can lead to a reduction in maxillomandibular length and lower facial height. Arifin stated that girls who consumed more animal protein than vegetable protein, and fat from ages 6

to 8 experienced an earlier peak of growth.<sup>17</sup> Nutrients that are essential for normal postnatal growth such as calcium, magnesium, phosphorus, fluoride, vitamin A, and vitamin D are needed for bone growth.<sup>5</sup> Good nutrition can provide normal bone growth. Calcium, phosphorus, magnesium, manganese, and fluoride are essential for the growth of good bones and teeth.<sup>4,18</sup> Vitamin A controls the activity of osteoblasts and osteoclasts. Deficiency of essential amino acids, essential fatty acids, vitamins, or minerals also affects skeletal maturation. Vitamin D is a good nutrient for bone growth because it contains calcium that bones need. Poor nutritional intake will cause interference with growth in height, age, and bone structure.<sup>4,18</sup>

We found in this study the test results of maxillary length and mandibular length to be statistically positive significant with chronological age (9–15 years). The maxilla and mandible are bones that can provide an overview of gender differences because males and females have morphological differences in each of these bones.<sup>14</sup> Based on the research of Azhari, et al.<sup>19</sup> in men and women aged 9–25 (and also the study of Astuti, et al.<sup>14</sup>), the maxillary and mandibular growth was higher in men than in women aged 15–25. The study also outlined the functioning of the different types of hormones between the sexes, such as the difference in testosterone levels between men and women, where men are heavily influenced by the hormone testosterone and women are heavily influenced by the hormones estrogen and progesterone. Regarding the size and mass of muscle and bone, as well as changes in facial shape, the hormone estrogen plays an important role in bone metabolism, in this case affecting the regulation of osteoblast and osteoclast activity by paying attention to the speed of resorption and bone formation taking place at the same rate (under normal conditions) so that bone mass remains constant.<sup>4,12</sup>

Litsas<sup>20</sup> states that somatotropin (growth hormone or, GH) is an important factor in craniofacial and skeletal growth during childhood and adulthood. GH can increase bone elongation by stimulating maturation and cell division of chondrocytes in the epiphyseal plate; thus, there is a continuous widening of the disc and production of more cartilage for bone formation.<sup>20</sup> Another factor that can affect the growth of the maxilla and mandible is the environment. One of the environmental factors that can influence is habit. Abnormal habits affect facial growth patterns, which have an important influence on craniofacial growth and occlusal physiology. Abnormal habits or bad habits can affect or inhibit bone growth, cause malposition of teeth, breathing difficulties and speech disorders, disrupt facial muscle balance, and create psychological problems. Examples of these bad habits are thumb sucking and finger sucking, sticking out of the tongue, sucking and biting lips, poor posture, and biting nails, among others.<sup>21</sup> The research conducted is in line with the research of Enikawati, et al.<sup>4</sup>, that the increase in maxillary length in males is greater than in females and the mandibular length in males is greater than in females aged 10–16, which is influenced by genetic, hormonal and nutritional factors.

To conclude, there was a significant positive relationship between chronological age and maxillary and mandibular lengths of ethnic Bataks aged 9–15. The small but statistically significant gender differences in mandibular and maxillary lengths may not be clinically significant. Taking into consideration the ethnic features, age and gender of the patients, plays a critical role in setting objectives for successful orthodontic treatment. Thereby, a single set of Batak norms from the McNamara analysis may be advisable and practical in orthodontic diagnosis.

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