

Mandibular Arch Width in Stunted and Non-Stunted Children From High-Stunting Areas in Bandung, Indonesia: A Panoramic Radiographic Study

Muhammad Rizky Zen

Universitas Padjadjaran

Deni Sumantri Latif

Universitas Padjadjaran

Arlette Suzy Setiawan

arlette.puspa@unpad.ac.id

Universitas Padjadjaran

Research Article

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Abstract

Background

Stunting is a chronic nutritional condition that may affect skeletal growth, including craniofacial development. However, evidence regarding its association with mandibular arch dimensions in early childhood remains limited. This study aimed to compare mandibular arch width between stunted and non-stunted children aged 3–7 years using panoramic radiographs.

Methods

This cross-sectional study used secondary panoramic radiographic data from 61 children aged 3–7 years, consisting of 30 stunted and 31 non-stunted children. Stunting status was determined based on height-for-age z-scores according to the WHO growth standards. Mandibular intercanine and intermolar widths were measured on digital panoramic radiographs using WebCeph software and expressed in pixel units. Intra-observer reliability was assessed using intraclass correlation coefficients. Normality was evaluated using the Shapiro–Wilk test, and between-group comparisons were performed using independent-samples t-tests or Welch’s t-tests, as appropriate. Effect sizes were calculated using Cohen’s d.

Results

Children in the stunted group showed smaller mandibular arch widths than non-stunted children. The mean intercanine width was 130.47 ± 14.47 pixels in the stunted group and 145.42 ± 18.81 pixels in the non-stunted group, with a mean difference of 14.95 pixels (95% CI: 6.36–23.54; $p = 0.001$; Cohen’s $d = 0.89$). The mean intermolar width was 255.97 ± 25.14 pixels in the stunted group and 288.97 ± 43.63 pixels in the non-stunted group, with a mean difference of 33.00 pixels (95% CI: 14.74–51.26; $p < 0.001$; Cohen’s $d = 0.92$). Intra-observer reliability was excellent for both intercanine and intermolar measurements.

Conclusion

Stunted children showed significantly smaller mandibular intercanine and intermolar widths than non-stunted children. These findings suggest that chronic growth impairment may be associated with reduced transverse mandibular arch development in early childhood.

Introduction

Malnutrition continues to be a major public health problem among children.^{1,2} It is often reflected by anthropometric indicators such as wasting, underweight and stunting. Of these, stunting reflects chronic

growth impairment and is defined as a height-for-age z-score that is below – 2 standard deviations based on World Health Organization growth standards.³ Stunting is a sign of chronic nutritional deficiency and is a measure of the combined effects of poor dietary intake, recurrent infection and poor environmental conditions during the critical periods of growth.⁴

Stunting remains a major problem for children under five years of age worldwide. Despite a decline in the rate of stunting in Indonesia over the past decade, it remains higher than the national target and continues to be a major child health problem.^{5–8} The persistence of stunting is important because its consequences are more than just a failure of linear growth.⁴ Undernutrition in the early years of life can also impact brain development, motor skills, bone growth and health in later years.⁶

Chronic nutritional deficiency may also affect craniofacial growth.⁹ The mandible is the largest bone of the craniofacial complex and plays an important role in mastication, speech, the development of occlusion, and the morphology of the lower face.¹⁰ Its growth is regulated by genetic, hormonal, functional and environmental factors including nutritional status.¹¹ Deficiencies of macronutrients and micronutrients such as protein, calcium, phosphorus, and vitamin D may compromise matrix synthesis, mineralisation, and skeletal growth. Therefore, children with chronic growth impairment may be at risk of altered mandibular development, including decreased transverse arch dimension.^{12,13}

The width of the mandibular arch is of clinical importance as inadequate transverse development can result in crowding, changes in occlusion and functional disturbances during the transition period of primary to mixed dentition.¹⁴ The 3–7 year age range is an important developmental phase as the primary dentition is generally established and the early mixed dentition commences.¹⁵ The changes found in the dimensions of the mandibular arch during this period may provide useful information on the influence of disturbances in growth in early life on craniofacial development.¹⁶

Although it is biologically plausible that stunting is associated with mandibular development, there are few studies on mandibular arch dimensions in stunted children with inconsistent findings. Studies previously found no significant difference in the dimensions of the jaw arch between stunted and non-stunted children and recommended further research using standardised radiographic measurements and well defined age groups.¹⁷ Data on Indonesian children, especially in the early childhood period when mandibular arch development is still active, are still limited.

Hence, this study aimed to compare the mandibular arch width between stunted and non-stunted children aged 3–7 years using panoramic radiographs. The findings are anticipated to add to the knowledge of the association between chronic growth failure and craniofacial development in children.

Methods

Study design and setting

The panoramic radiographs of children aged 3–7 years from three high-stunting areas in Bandung City, Indonesia, namely Sukajadi, Regol, and Bandung Kidul districts, were used in this analytical cross-sectional study. Radiographic examinations had been conducted at the Dental Hospital of Universitas Padjadjaran, Bandung, between June 2024 and February 2025.

Participant recruitment and sample selection

Subjects in the group of stunted children were recruited from three areas in Bandung City with a high burden of stunting. One hundred seven stunted children were invited to undergo panoramic radiographic examination at the Dental Hospital of Universitas Padjadjaran. Of these, 52 children were cooperative enough for the procedure to be carried out. After applying the inclusion and exclusion criteria, a total of 30 children were included in the final stunted group.

Children in the non-stunted group were selected from the same three areas to improve comparability between groups. A total of 45 non-stunted children were invited, of whom 39 were cooperative and successfully underwent panoramic radiography. After applying the inclusion and exclusion criteria, 31 children were included in the final non-stunted group. The final sample included 61 panoramic radiographs, comprising 30 stunted and 31 non-stunted children (Diagram 1).

Diagram 1. Flow of Participant Recruitment

Radiographs were included if they belonged to children aged 3–7 years with available anthropometric data for nutritional status classification and had adequate image quality for measurements of the mandibular arch. The criteria for adequate image quality were as follows: the contrast, density, and sharpness should be acceptable; there should be minimal distortion; no overlapping that would interfere with the measurement landmarks; and head positioning should be acceptable. Radiographs were excluded if the child had craniofacial congenital anomaly, a history of facial or mandibular trauma, previous orthodontic treatment, premature loss of the mandibular primary canines or second primary molars, poor image quality, or unclear anatomical landmarks required for measurement.

Nutritional status classification

According to the WHO growth standards, nutritional status was classified through height-for-age z-scores. Those who had their height-for-age z-scores below -2 standard deviations were stunted, while those with height-for-age z-scores between -2 and $+2$ standard deviations were considered non-stunted. The anthropometric assessment and nutritional status classification were based on the data obtained from trained health personnel in the community health service areas.

Radiographic procedure and measurements

All children who met the inclusion criteria were referred to the Dental Hospital of Universitas Padjadjaran for panoramic radiographic examination. The same radiographic unit and imaging procedure were used to obtain all panoramic radiographs. Mandibular arch width was assessed using two linear parameters: intercanine width and intermolar width. Intercanine width was the linear distance from the cusp tips of the right and left mandibular primary canines. Intermolar width was the linear distance between the mesiobuccal cusp tips of the right and left mandibular second primary molars. All measurements were done on digital panoramic radiographs using WebCeph software from AssembleCircle Corp., version 0.9.91.

All measurements were recorded in pixel units. This is because pixel-based measurements were used as all radiographs were obtained using the same panoramic radiographic unit and standardized imaging protocol, making valid relative comparisons between groups. Thus, the values should be interpreted as radiographic linear measurements rather than absolute anatomical dimensions in millimeters.

Intraobserver agreement

Intra-observer reliability was assessed by selecting about 25% of the radiographs at random and re-measuring them by the same examiner after a two-week interval to minimise recall bias. Reliability was assessed by interclass correlation coefficient (ICC) using a two-way mixed effects model, absolute agreement. Acceptable ICC values were ≥ 0.75 , whereas ICC values > 0.90 were interpreted as excellent reliability.

Statistical analysis

Descriptive statistics were presented as mean, standard deviation, median, minimum and maximum values. Shapiro–Wilk test was used to test the normality of numerical data. The homogeneity of variance was examined using Levene’s test. Between-group comparisons were performed using an independent-samples t-test if the assumptions of normality and homogeneity of variance were met. Welch’s t-test was used when variances were unequal, and Mann–Whitney U test was used when data were not normally distributed. Statistical significance was defined as $p < 0.05$. Effect sizes were estimated by using Cohen’s d to measure the magnitude of differences between the stunted and non-stunted groups.

Ethical considerations.

This study was approved by the Health Research Ethics Committee of Universitas Padjadjaran (Approval No. 855/UN6.KEP/EC/2024, extended under Approval No. 300/UN6.KEP/EC/2026) and was conducted in accordance with the Declaration of Helsinki. Prior to the panoramic radiographic examination, written informed consent was obtained from the parents or legal guardians. Child cooperation and assent were considered during the radiographic procedure, and children who were unable or unwilling to cooperate were not subjected to imaging.

Results

Participant flow and characteristics

The distribution of participants by age and sex is presented in Table 1. In the non-stunted group, there were 11 boys (35.5%) and 20 girls (64.5%). In the stunted group, there were 14 boys (46.7%) and 16 girls (53.3%). The largest age group in the non-stunted group was 5 years, whereas the largest age group in the stunted group was 4 years.

Table 1
Distribution of participants according to age, sex, and nutritional status

Characteristic	Non-stunted (n = 31)	Stunted (n = 30)
Sex		
Boys	11 (35.5%)	14 (46.7%)
Girls	20 (64.5%)	16 (53.3%)
Age, years		
3	8 (25.8%)	5 (16.7%)
4	8 (25.8%)	14 (46.7%)
5	9 (29.0%)	6 (20.0%)
6	4 (12.9%)	4 (13.3%)
7	2 (6.5%)	1 (3.3%)

Mandibular arch width

The descriptive and comparative analyses of mandibular arch width are shown in Table 2. The mean intercanine width was lower in the stunted group than in the non-stunted group (130.47 ± 14.47 pixels vs. 145.42 ± 18.81 pixels). The mean difference was 14.95 pixels (95% CI: 6.36–23.54), and the difference was statistically significant ($t = 3.47$; $p = 0.001$), with a large effect size (Cohen’s $d = 0.89$).

Table 2
Comparison of mandibular arch width between stunted and non-stunted children

Measurement	Non-stunted (n = 31), mean $\pm$ SD	Median (min–max)	Stunted (n = 30), mean $\pm$ SD	Median (min–max)	Mean difference (95% CI)	t	p-value	Cohen's d
Inter canine width, pixels	145.42 $\pm$ 18.81	143.00 (110–200)	130.47 $\pm$ 14.47	131.00 (104–162)	14.95 (6.36–23.54)	3.47	0.001	0.89
Inter molar width, pixels	288.97 $\pm$ 43.63	291.00 (233–471)	255.97 $\pm$ 25.14	254.50 (216–315)	33.00 (14.74–51.26)	3.60	< 0.001	0.92

Similarly, the mean intermolar width was lower in the stunted group than in the non-stunted group (255.97 $\pm$ 25.14 pixels vs. 288.97 $\pm$ 43.63 pixels). The mean difference was 33.00 pixels (95% CI: 14.74–51.26), and the difference was statistically significant (t = 3.60; p < 0.001), with a large effect size (Cohen's d = 0.92).

Intra-observer reliability

Intra-observer reliability was excellent for both measurements. The intraclass correlation coefficient was 0.990 for intercanine width and 0.999 for intermolar width, indicating highly consistent repeated measurements.

Discussion

This study found that stunted children aged 3–7 years had significantly smaller mandibular arch widths compared with non-stunted children as determined by intercanine and intermolar measurements. Inter canine width (p = 0.001) and Inter molar width (p < 0.001) were found to be statistically significant and the effect sizes were large. These findings suggest a possible relationship between chronic growth impairment and smaller transverse mandibular arch dimensions in early childhood.

The reduced intercanine and intermolar widths observed in the stunted group may be biologically plausible. Stunting reflects chronic nutritional deprivation, especially during the early life period when skeletal growth and mineralisation are very active.¹⁸ Formation of the bone matrix and mineral deposition requires adequate intake of protein, calcium, phosphorus, vitamin D and other micronutrients.^{19,20} Deficiency of these nutrients can influence bone apposition and maturation including the craniofacial complex. The mandible is actively growing during childhood and so chronic undernutrition may be a factor in the reduced transverse development of the mandibular arch.²¹

The 3–7 year age range is of clinical relevance as the primary dentition is generally established and the early mixed dentition period begins.²² The mandibular arch width during this developmental stage provides information on transverse dental arch development. Inter canine width is the anterior transverse dimension of mandibular arch, inter-molar width is the posterior transverse dimension. In the stunted children the values were consistently smaller in both measurements.²³ This indicates that the difference was not confined to one particular segment of the arch, but involved both anterior and posterior dimensions.

The result is different from the previous study in Surabaya, which showed no significant difference in jaw arch dimension between stunted and non-stunted children.¹⁷ This discrepancy may be attributed to several reasons, such as age range, population characteristics, measurement method and dental landmarks used. The study was carried out on children aged 3–7 years and the mandibular primary canines and second primary molars were measured which are relevant landmarks in the primary and early mixed dentition stages. However, the use of different landmarks or older age groups in studies may represent different phases of arch development, especially when the permanent teeth are beginning to erupt.

All subjects were assessed for mandibular arch width using panoramic radiographs and a standardised method. All radiographs were taken using the same panoramic radiographic unit and the same imaging protocol, which allows valid relative comparisons between the groups. However, measurements obtained from panoramic radiographs should be considered radiographic linear measurements rather than true anatomic distances, since panoramic imaging is subject to magnification, projection, and possible distortion.²⁴ Thus, in the current study we used pixel-based measurements for relative group comparison instead of absolute clinical measurements in millimetres.

A major strength of this study is its measurement reliability. The intra-observer reliability analysis revealed excellent agreement with the ICC of 0.990 for inter canine width and 0.999 for intermolar width. The results show that landmark identification and repeated measurements had very high reproducibility. Another strength is recruitment of children with and without stunting from the same districts in Bandung which may reduce environmental heterogeneity between groups.

The results of this study may have implications for public health and clinical care. Reduced mandibular arch width in stunted children may suggest the need for early monitoring of oral and craniofacial growth in children with chronic nutritional deficiency. Dentists, paediatric dentists, orthodontists, and public health professionals should recognise that the consequences of stunting may extend beyond general growth to include craniofacial development. Early nutritional intervention and oral health monitoring may help to identify children at risk for future dental arch problems such as crowding or transverse discrepancies.^{25,26}

This study has a number of limitations. First, the cross-sectional design does not allow for causal inference between stunting and mandibular arch width. Secondly, age and sex were not statistically

controlled, but both may influence dental arch dimensions. Third, not all age groups had an equal number of participants, and subgroup analysis by age was not performed due to the limited sample size. Fourth, the measurements obtained from panoramic radiography were in pixels, so they could not be directly compared with the normative values reported in millimetres. Fifth, child cooperation during radiographic examination might have influenced the final sample as not all invited children could or would be subjected to panoramic imaging. Further studies with larger samples, age and sex matched groups, calibrated measurements and longitudinal designs are necessary to confirm these findings and to clarify the developmental pathway between early-life stunting and mandibular growth.

In brief, the children with stunting in this study had smaller mandibular intercanine and intermolar widths than non-stunted children. These results suggest a link between chronic growth retardation and decreased transverse development of the mandibular arches in early childhood.

Conclusion

Stunted children aged 3–7 years showed significantly smaller mandibular intercanine and intermolar widths than non-stunted children based on panoramic radiographic measurements. These findings suggest that chronic growth impairment may be associated with reduced transverse mandibular arch development in early childhood. Further longitudinal studies with larger samples and calibrated measurements are needed to confirm the relationship between stunting and mandibular growth.

Declarations

Conflict of Interest:

The authors declare no conflict of interest.

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Author Contribution

ASS: Conceptualization, Methodology, Data curation, Investigation, Writing – review & editing. DSL: Supervision, Validation. All authors have read and approved the final manuscript. MRZ: Investigation, Formal analysis, Writing – initial draft.

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Data Availability Statement:

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request. Data are not publicly available due to ethical considerations and to protect the confidentiality of participants.

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Figures

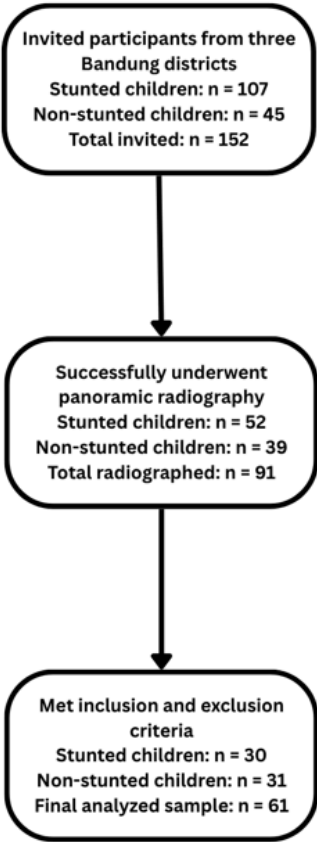


Figure 1

Diagram 1. Flow of Participant Recruitment