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# The correlation of head posture (NSL/OPT angle) with maxilla and mandible relation (ANB angle) by cephalometric analysis (Review of Deutro Malay children aged 10–12 years in Jakarta)

**Annisa Galuh Rahmawati Hendra Putri[1], Sarworini B. Budiardjo[2], Margaretha Suharsini[2]**
[1]Resident of Pediatric Dentistry Department, Faculty of Dentistry, Universitas Indonesia, Jakarta, Indonesia
[2]Department of Pediatric Dentistry, Faculty of Dentistry, Universitas Indonesia, Jakarta, Indonesia

## ABSTRACT

***Background:*** *Proper head posture involves an upright head with minimal muscle work and maximum mechanical efficiency in the central nervous system. Muscular imbalance in the cervical spine and stomatognathic system affects head posture and maxillary–mandibular malrelation. Age 10–12 years is the golden period for orthodontic treatment, for which an assessment of head posture needs to be considered. The nasion-sella line/odontoid process tangent (NSL/OPT) angle represents flexion–extension of the head posture; the A point, Nasion, B point (ANB) angle is used to determine the maxillary–mandibular relationship. No research has ever been conducted on the relationship between the NSL/OPT and ANB angles in children of the Deutro Malay race aged between 10 and 12 years.* ***Purpose:*** *This study aims to analyze the relationship between the NSL/OPT and ANB angles in children of the Deutro Malay race aged between 10 and 12 years.* ***Methods:*** *This research was conducted at the Pediatric Dental and Radiology Clinic of Universitas Indonesia Dental Hospital with 33 respondents aged between 10 and 12 years, taking the inclusion and exclusion criteria into account. Lateral cephalometric radiographs were taken, and the NSL/OPT and ANB angles were determined using ImageJ software. Data analysis was conducted using the Pearson correlation test.* ***Results:*** *The mean values for the NSL/OPT and ANB angles are 97.9 and 3.15, respectively. The correlation test result ($r = 0.067$; p-value $= 0.713$) indicates an immensely weak relationship between the NSL/OPT and ANB angles and is not significant.* ***Conclusion:*** *The results demonstrated that there was an exceedingly weak linear relationship; it can be concluded that the angle of head posture cannot be correlated to the ANB angle.*

***Keywords:*** *ANB angle; Deutro Malay; head posture*
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Correspondence: Sarworini B. Budiardjo, Department of Pediatric Dentistry, Faculty of Dentistry, Universitas Indonesia, Jakarta, Indonesia. Email: sarworini.b@ui.ac.id

## INTRODUCTION

Posture is the body's position resulting from the interaction between the musculoskeletal and central nervous systems. Head posture is described as an upright position of the head so that the body's ears, shoulders, and midline are aligned. It is further divided into flexed, neutral, and extended head postures. Posture plays a significant role in maintaining the body's balance and protecting its supporting structures from injuries or deformities.[1,2]

The stomatognathic system consists of the maxilla, mandible, muscles, temporomandibular joints, and soft tissues such as salivary glands, nerves, and blood vessels. The system is responsible for mastication, swallowing, and speech functions. All components of the stomatognathic system are connected to the skull and cervical spine through the temporomandibular joint, muscles, and ligaments in the cervical region. The temporomandibular joint, cervical spine, hyoid bone, and the surrounding neuromuscular structures form a system known as the cranio-cervico-mandibular unit.[3,4]

The relationship between craniofacial morphology and variations in head posture has been extensively reported in previous studies. The functional principles of the cervical spine have gained attention in the fields of orthodontics and orthopedics. Solow's soft tissue stretching hypothesis postulates that the subcutaneous soft tissue layers and underlying muscles passively stretch when the head is


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extended in relation to the cervical column. This elongation leads to increased mechanical load on the skeletal structures. The forces acting on these muscles restrict the forward growth of the maxilla and mandible.[5]

Proper postural alignment keeps the body balanced and parallel, optimizing mechanical efficiency by minimizing muscular workload. In contrast, suboptimal posture impairs the function of surrounding musculature, exerting detrimental effects on craniofacial morphology, particularly the maxilla–mandible relationship and head posture.[6]

One of the dimensions to assess head posture is the NSL/OPT angle, formed by the nasion-sella line (NSL) and the odontoid process tangent (OPT); it is a reference point that relates the posture of the head to a line representing the cervical column. The NSL/OPT angle has been widely used for head posture assessment in prior research.[7]

Indonesia is a country characterized by its diverse ethnicities and races. Deutro Malay is one of the largest ethnic groups in Indonesia. However, research on the relationship between head posture and malocclusion in Indonesian children of this race remains scarce. Therefore, this study aims to analyze the correlation between the NSL/OPT angle of head posture and the A point, Nasion, B point (ANB) angle using cephalometric analysis in children of the Deutro Malay race, aged between 10 and 12 years, at the pediatric dental clinic, Universitas Indonesia Dental Hospital. Craniofacial growth and development have reached approximately 80% by the age of 10–12 years.[1,2,8–10]

## MATERIALS AND METHODS

This is a correlative analytic study with a cross-sectional design using cephalometric radiographs as samples obtained from 10–12-year-old children of the Deutro Malay race. The research was conducted from November to December 2022 at the pediatric dental clinic and radiology clinic of Universitas Indonesia Dental Hospital with a sample of 33 lateral cephalometric photographs.

The inclusion criteria for the research were lateral cephalometric radiographs of children aged 10–12 years of Deutro Malay descent, with both parents not previously undergone but indicated for orthodontic treatment. A high-quality photograph with satisfactory levels of contrast, detail, and sharpness was required for the samples. Exclusion criteria included children with special needs, mouth-breathing habits, and postural abnormalities and the presence of artifacts on cephalometric photographs. The research sample was calculated using the sample size formula for correlative analytic research with a minimum sample size of 30. The sample population was selected by purposive sampling.

Prior to conducting the study, the researcher obtained ethical approval certification number 051661122 from the Dental Research Ethics Committee, Faculty of Dentistry, Universitas Indonesia. Subsequently, inter-operator and intra-operator reliability tests were performed using the Intraclass Correlation Coefficient (ICC). Afterward, subjects meeting the inclusion and exclusion criteria were selected, and informed consent was obtained from their parents/guardians. Radiographic images were captured from eligible subjects, and cephalometric measurements from these images were input into ImageJ software for angle analysis. The software facilitated the identification of S, N, cv2tg, cv2ip, A, and B points. The ANB angle represents the maxilla–mandible relationship. The NSL/OPT angle, which primarily determines the head posture, represents the intersection of the SN and OPT lines (the line that connects cv2tg and cv2ig points), was measured (Figure 1).

The data obtained were computed and subjected to data processing. Data analysis was performed using SPSS. The normality test was conducted using the Shapiro–Wilk test for samples less than 50. The data homogeneity was analyzed using Levene's test. Subsequently, univariate analysis was performed. The relationships between head posture and class I and II malocclusions were analyzed using Pearson's correlation test for normally distributed data and Spearman's correlation test for not normally distributed data. Correlation coefficients (r) ranging from 0 to 0.25 were considered very weak, from 0.26 to 0.5 as moderate, from 0.51 to 0.75 as strong, and from 0.76 to 1 as very strong, with a significance level set at $p < 0.05$.

## RESULTS

The study was conducted at the Pediatric Dentistry and Radiology Clinics of Universitas Indonesia Dental Hospital

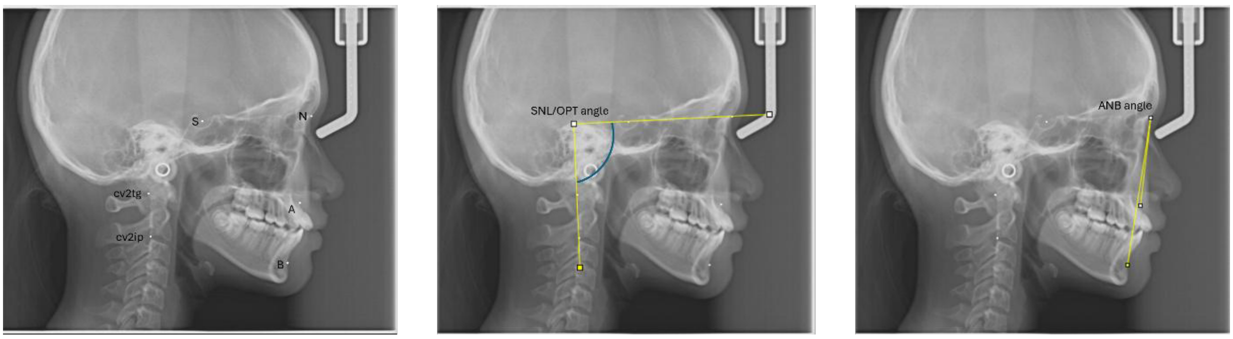


**Figure 1.** The identification of the reference point and the determination of NSL/OPT and ANB angles.


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with the aim of analyzing the relationship between the NSL/OPT flexion–extension angle of head posture and the ANB angle representing the maxilla–mandible relationship in 10–12-year-old children of Deutro Malay ethnicity. It was an analytical correlational study with a cross-sectional design. The sample size consisted of 33 lateral cephalometric radiographic images of satisfactory radiographic quality with optimal contrast, detail, and sharpness from children who met the inclusion criteria, namely 10–12-year-old children of Deutro Malay descent from both parents, who had not received orthodontic treatment and were cooperative during sample collection.

In this study, head posture measurement was determined by the NSL/OPT angle, which represents the intersection angle between the SN line (connecting the sella and nasion points) and the OPT line (connecting the cv2tg and cv2ip points), presented as numerical data. On the other hand, malocclusion measurement was assessed using the ANB angle (formed by the subspinale, nasion, and supramentale points), which was also presented as numerical data.

Reliability testing of the NSL/OPT and ANB angles was conducted using the ICC for both inter-operator and intra-operator assessments. Inter-operator ICC testing was performed by the researcher and a peer researcher on 10 lateral cephalometric radiographic image samples, resulting in an ICC value of 0.927 for the ANB angle and 0.978 for the NSL/OPT angle, exhibiting excellent agreement. The intra-operator ICC values were 0.994 for the ANB angle and 0.981 for the NSL/OPT angle, also representing excellent agreement.

Furthermore, the Normality test was carried out to examine the distribution of research data. The Shapiro–Wilk test was used, considering that the sample size was less than 50. The Shapiro–Wilk test results produced a $p$-value of 0.1 ($p \geq 0.05$) for the ANB angle and a $p$-value of 0.933 ($p \geq 0.05$) for the NSL/OPT angle. These results indicate that the data follows a normal distribution. Therefore, the Pearson correlation test was used to analyze the relationship between head posture and malocclusion in this study.

A homogeneity test was conducted to evaluate the similarity of characteristics in the female and male samples with respect to the ANB and NSL/OPT angles. The homogeneity test results showed a $p$-value of 0.456 (> 0.05) for the ANB angle and 0.452 (> 0.05) for the NSL/OPT angle. Based on these results, it can be concluded that the male and female samples in this study were homogeneous (Table 1).

**Table 1.** The Homogeneity test result for the head posture and ANB angle according to gender

| Variable | *p*-value | Data Variance |
|---|---|---|
| Head posture (NSL/OPT Angle) | 0.456 | Homogen |
| ANB Angle | 0.452 | Homogen |

The mean values of the measured angles for head posture and malocclusion were as follows: head posture had an average angle of 97.9 with a standard deviation of 9.24, while malocclusion had a mean angle of 3.17 with a standard deviation of 2.04. The Pearson correlation analysis results indicate a weak and nonsignificant relationship between head posture and malocclusion in 10–12-year-old children of the Deutro Malay race, with a $p$-value $\geq 0.05$ and the coefficient correlation (r) of 0.067 (Table 2).

## DISCUSSION

This study is an analytical correlational research aimed at investigating the association between head posture and the ANB angle in Deutro Malay children, specifically those aged 10–12 years, residing in Jakarta. The craniofacial structure and cervical bone are anatomically and functionally interconnected entities that mutually influence each other's growth patterns. The positioning of the head and the stomatognathic system are connected through the temporomandibular joint, as well as the surrounding muscles and ligaments. These elements, including the temporomandibular joint, cervical bone, hyoid bone, and their adjacent neuromuscular structures, constitute a comprehensive system known as the cranio-cervico-mandibular unit. According to the theory of soft tissue stretching, optimal head posture can be maintained by achieving a balance of tension among the cranio-cervical bones, myofascial structures, and dental occlusion. Conversely, any imbalances within this cranio-cervico-mandibular unit may lead to alterations in head posture and subsequently impact the relationship between the jaws.[3,4,11–13]

Previous studies have indicated that head posture and jaw relationship mutually influence each other. In the presence of abnormal head posture, excessive muscle tension occurs around the cervical bones, which is transmitted through the temporomandibular joint and can result in changes in jaw relationship. Malocclusion can also lead to imbalances in the masticatory muscles, which can cause alterations in head posture. When the maxilla is protruded, the head tends to extend as compensation for the maxillary position.

**Table 2.** The relationship between head posture and ANB angle in 10–12-year-old Deutro Malay children

| Variable | n | Average ± SD (degree) | r | *P* value |
|---|---|---|---|---|
| Head Posture (NSL/OPT angle) | 33 | 97.9 ± 9.24 | 0.067 | 0.713* |
| ANB Angle | | 3.17 ± 2.04 | | |

*Pearson Test, p<0.05


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In contrast, in the case of mandibular protrusion, the head tends to flex as a compensatory mechanism.[1,14]

The analysis of head posture is crucial for dentists, particularly pediatric dentists, in diagnosing malocclusion and determining orthodontic treatment plans. It plays a significant role in the prevention and treatment of malocclusion and orthopedics, allowing for the prevention of more severe malocclusion and head posture abnormalities. Furthermore, consideration of head posture is vital in improving the success of orthodontic treatment and preventing relapses. By taking head posture into account, dentists can enhance treatment outcomes and maintain the long-term stability of orthodontic corrections.[1,13]

The respondents in this study are 10–12-year-old children of the Deutro Malay race. Physiologically, the head posture in children becomes relatively stable by eight years. Additionally, maxillary expansion occurs rapidly until age 10 and starts to stabilize thereafter. The age range of 10–12 years corresponds to the late mixed dentition period. By age 12, the final occlusal contacts occur as the permanent dentition is established, and the permanent second molars in the upper and lower arches begin to erupt. Craniofacial growth and development have reached approximately 80% level by the age of 10–12 years, with the remaining growth and development occurring until 20 years. The age range of 10–12 years is considered a critical period for orthodontic treatment.[15,16]

Indonesia is a country with a diverse range of ethnicities, with the Mongoloid race as one of the largest ethnic groups. The Mongoloid race is divided into two subgroups: Deutro Malay and Proto Malay. The Deutro Malay subgroup includes ethnic groups such as the Betawi, Javanese, Minangkabau, Palembang, Balinese, Madurese, and Makassarese, prevalent in Jakarta, Indonesia.[8]

The researchers chose Universitas Indonesia Dental Hospital as the data collection site. This decision was based on the fact that Universitas Indonesia Dental Hospital is one of Jakarta's central referral dental hospitals. Therefore, patients visiting Universitas Indonesia Dental Hospital are considered representative of the Deutro Malay population in Jakarta.

Several methods can be used to analyze head posture. The simplest being visual analysis, which involves qualitative observation of posture. However, this analysis is considered to have poor credibility regarding quantitative measurements. Another method is bio-photogrammetry analysis. This method is simple, non-invasive, and cost-effective. The analysis is performed by measuring angles and lines between points marked on the body. Measurements can be viewed and interpreted through digital photographic records. In this study, the chosen method is lateral cephalometric radiography. This method is the most accurate for analyzing head posture. Analysis using lateral cephalometric radiographic images is considered the most objective and provides a clear view of the cranio-cervico-mandibular structures without the influence of soft tissues.[14] Lateral cephalometric radiography is also a standard examination in orthodontic treatment used for diagnosing malocclusion and determining treatment plans. It can be used to evaluate the relationship between the maxilla and the mandible.[17–19]

In this study, a total of 35 lateral cephalometric radiographic images were initially obtained. However, two lateral cephalometric radiographs could not be used because they did not meet the inclusion and exclusion criteria. One image was obtained from a child with a postural abnormality noticeable in their slightly uneven gait. Body posture abnormalities can cause changes in head posture, which could introduce bias to the research data. Additionally, one image could not be used due to artifacts in the radiographic image, which resulted in unclear radiographic views in certain areas and difficulties in determining reference points. This could have led to inaccurate determination of reference points, yielding imprecise data, thus excluding this sample from the research. At the end of the study, 33 lateral cephalometric radiographic images that met the inclusion and exclusion criteria were obtained, surpassing the minimum required sample size for the study.

In general, ethnicity and age are potential factors that can influence the development of head posture. Chronic conditions that affect changes in head posture and malocclusion should be considered when evaluating their relationship; these conditions include upper airway obstruction, commonly caused by conditions such as adenoid hypertrophy, allergies, and obstructive sleep apnea. To maintain the airway, patients with upper airway obstruction unconsciously position their heads in extension, leading to an increased cranio-cervical angle. Temporomandibular joint disorders should also be considered when assessing the relationship between head posture and malocclusion. Patients with temporomandibular joint disorders often experience musculoskeletal disturbances. Previous studies have suggested that temporomandibular joint disorders accompanied by dysfunction of masticatory muscles can potentially contribute to abnormal head posture development. This can occur because the temporomandibular joint is connected to the cervical region through muscles and ligaments. Therefore, diseases or disorders such as upper airway obstruction and temporomandibular joint disorders should be considered factors influencing head posture and malocclusions.[12]

Several variables in cephalometric analysis can represent head posture, such as craniovertical angles (NSL/VER, NL/VER), cervicohorizontal angles (OPT/HOR, CVT/HOR), cranioservical angles (NSL/OPT, NSL/CVT, NL/OPT, NL/CVT), and cervical curvature angle (OPT/CVT). They are globally accepted as angles to be measured in determining head posture. The cranioservical angle is the head posture angle that has the strongest relationship with craniofacial morphology compared to the craniovertical angle. In this study, the NSL/OPT angle is used based on several considerations. The N and S points used to determine the NS line are also points used in orthodontic diagnosis, which is expected to facilitate head posture assessment during orthodontic diagnoses. Additionally, the resistance


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formed by the weight of the head at the center of gravity is near the sella turcica point. The OPT line is formed by the most inferior-posterior and superior-posterior points of the C2 cervical bone. The C2 cervical bone is easily visible, and its points can be determined through cephalometric radiographs.[9,12]

The ANB angle is used in Steiner's analysis to measure the relative position of the maxilla and mandible in the anteroposterior plane. The ANB angle is the most used angle in cephalometric analysis to assess the relationship between the maxilla and mandible and can represent the maxillomandibular relationship. The assessment of the ANB angle is based on the difference between the SNA and SNB angles.[20]

In the study by Di Giacomo et al.,[4] it was mentioned that there is no correlation between head posture and the ANB angle with angles $\geq 5$ in respondents without temporomandibular joint disorders. A study conducted in the Chinese population of children aged 6–11 years also did not find a correlation between head posture and the ANB angle. These results are consistent with the findings of this study, which demonstrated a Pearson correlation test result of $r = 0.067$ and $p > 0.05$ between the NSL/OPT angle and the ANB angle, indicating a weak and not significant correlation. This could be due to the presence of other factors that also influence head posture and malocclusion, such as temporomandibular joint disorders, crowded teeth, and posterior crossbite, which were not considered in this study. The measurements of the head posture only use the NSL/OPT angle. Therefore, various angles for assessing head posture should be analyzed and included to ensure a more comprehensive evaluation of head posture and malocclusions from all aspects, which may reveal stronger correlations between them.[4]

Due to limited access to the sample source, this research included a wide range of malocclusions. It would be preferable to include samples from each malocclusion classification, such as malocclusions class I, II, and III. The results demonstrated that there was a very weak linear relationship, and it can be concluded that the angle of head posture cannot be correlated to the ANB angle.[12,13,21]

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