J Oral Res
research in oral sciences

ORIGINAL ARTICLE

NASOLABIAL ANTHROPOMETRY USING 3D COMPUTED TOMOGRAPHY SCAN RECONSTRUCTION: BASELINE STUDY FOR NASOLABIAL CORRECTION IN INDONESIAN CHILDREN WITH CLEFT LIP AND PALATE

Antropometría nasolabial mediante reconstrucción con tomografía computarizada 3D: Estudio de referencia para la corrección nasolabial en niños Indonesios con fisura labiopalatina

Erli Sarilita,[1] Harry Galuh Nugraha,[2] Nani Murniati,[1] Endang Sjamsudin,[3] Harmas Yazid Yusuf.[3]

1. Department of Oral Biology, Faculty of Dentistry, Universitas Padjadjaran, Indonesia.
2. Department of Radiology, Faculty of Medicine, Universitas Padjadjaran, Indonesia.
3. Department of Oral Maxillofacial Surgery, Faculty of Dentistry, Universitas Padjadjaran, Indonesia.

ABSTRACT

Background: The normal nasolabial structure of infants and children from East Asian, specifically Indonesian, descent groups has been less explored in the literature. This anthropometric study is used as a guide in lip repair in patients with clefts. This retrospective study used archived CT images from the Indonesian population.

Materials and Methods: Computed tomography records of children under 5 years of age were extracted from a provincial hospital. The images were then filtered based on the inclusion and exclusion criteria and then the 2D slices were reconstructed using the open source software Invesalius. Twenty-five variable nasolabial parameters of the nasolabial structure were then measured in the 3D rendering mode. Images with craniofacial dysmorphism or cannulas that passed over the nasolabial structure were excluded. Results were summarized using descriptive statistics.

Results: Fourteen of 128 CT images were included in this study. The samples were divided into two age groups: 0-12 months and 25-54 months. There were moderate to strong, positive correlations between age and all nasolabial variables, which were statistically significant (p<0.05) except for nasal length, nares circumference, columella width, superior philtrum width, philtrum column height, and cutaneous upper lip height.

Conclusions: This study described anthropometric measurements of normal nasolabial structures as a reference point for lip correction surgery. However, to obtain more accurate anthropometric guidelines, further studies with larger sample sizes are desirable. Although surgical repair of the lip is usually performed within the first year of life, some cases of surgery are performed after infancy.

Keywords: *Indonesia; Anthropometry; Tomography; Cleft lip; Infant; Child, preschool.*

RESUMEN

Antecedentes: La estructura nasolabial normal de bebés y niños de grupos de ascendencia de Asia oriental, específicamente de Indonesia, ha sido menos explorada en la literatura. Este estudio antropométrico se utiliza como guía en la reparación del labio en pacientes con fisuras. Este estudio retrospectivo utilizó imágenes de tomografía computarizada archivadas de la población indonesia.

Materiales y Métodos: Se extrajeron los registros de tomografía computarizada de niños menores de 5 años de un hospital provincial. Luego, las imágenes se filtraron según los criterios de inclusión y exclusión y luego se reconstruyeron los cortes 2D utilizando el software de código abierto Invesalius. Luego se midieron veinticinco parámetros nasolabiales variables de la estructura nasolabial en el modo renderizado 3D. Se excluyeron imágenes con dismórfica craneofacial y cánula que pasa sobre la estructura nasolabial. Los resultados se resumen mediante estadística descriptiva.

Resultado: En este estudio se incluyeron catorce de 128 imágenes de TC. Las muestras se dividieron en dos grupos de edad: 0-12 meses y 25-54 meses. Hubo una correlación positiva de moderada a fuerte entre la edad y todas las variables nasolabiales, que fueron estadísticamente significativas (p<0,05) excepto la longitud nasal, la circunferencia de las narinas, el ancho de la columela, el ancho del filtrum superior, la altura de la columna del filtrum y la altura cutánea del labio superior.

Conclusión: Este estudio describió las medidas antropométricas de estructuras nasolabiales normales como base para la cirugía de corrección de labios. Sin embargo, para obtener directrices antropométricas más precisas, son deseables más estudios con tamaños de muestra más grandes. Aunque la reparación quirúrgica del labio normalmente se realiza dentro del primer año de vida, en algunos casos la cirugía se realiza después de la infancia.

Palabras Clave: *Indonesia; Antropometría; Tomografía; Labio leporino; Lactante; Preescolar.*

CORRESPONDING AUTHOR: Endang Sjamsudin. Department of Oral Maxillofacial Surgery, Faculty of Dentistry, Universitas Padjadjaran, Jl. Ir. Soekarno KM.21, Hegarmanah, Kec. Jati-nangor, Kabupaten Sumedang, Jawa Barat 45363, Indonesia. **E-mail:** erli.sarilita@fkg.unpad.ac.id

CITE AS: Sarilita E, Galuh Nugraha H, Murniati N, Sjamsudin E, Yazid Yusuf H. *Nasolabial anthropometry using 3D computed tomography scan reconstruction: baseline study for nasolabial correction in Indonesian children with cleft lip and palate.* J Oral Res. 2024; 13(1):150-159. doi:10.17126/joralres.2024.013

Received: February 12, 2023.
Accepted: May 24, 2024.
Published online: June 7, 2024.

ISSN Print 0719-2460
ISSN Online 0719-2479

INTRODUCTION

The most common craniofacial birth defect is cleft lip, with or without cleft palate.[1] The causes of Cleft Lip (CL), Cleft Palate (CP), and Cleft Lip and Palate (CLP) are believed to be multifactorial, involving a combination of various genetic and environmental factors.[2] However, the mechanism is known as fusion failure during the first trimester of the intrauterine period. Babies born with this condition will have increased morbidity if not treated1. Patients with clefts require lifelong multidisciplinary treatment, including surgical repair.[3] There is considerable variation in orofacial clefts (OFC) prevalence across different regions. The East Asia and Pacific region has the highest prevalence, with 1.69 OFC cases per 1,000 births.[4]

A variety of surgical repair techniques are discussed in the literature to repair the cleft lip conducted during the infancy. In cases of cleft lip, surgical repair surgery seeks to restore the lip's normal structure and function.[5] However, there are not many published articles presenting nasolabial anthropometric data of infants without cleft lip that can serve as guidelines for surgical planning and surgical evaluation of lip reconstruction, not limited to cleft lip repair.

Ideally, anthropometric study of nasolabial structure in infants is performed noninvasively, without unnecessary radiation exposure, capable of capturing 3D surfaces, and capable of providing accurate measurements in groups of uncooperative patients.[6] The aim of nasolabial quantitative study in infants with or without cleft varied depending on the subject types. Nasolabial study in infants without cleft provide a baseline for lip reconstruction surgery.[7]

Postsurgical nasolabial studies evaluate outcome measures of surgical cleft lip repair both transversely and longitudinally to look at the impact of facial growth on scarring.[8] Comparative pre- and postoperative studies of nasolabial structure in infants with cleft lip treated with nasoalveolar molding provide recommendations to clinicians.[9]

Nasolabial anthropometrics focusing on infants without cleft in the previous studies has been conducted utilizing nasolabial molding,[7] 3D photographs[10,11] and 2D photographs.[12] However, only a few studies have mentioned East Asian ancestry groups, including Indonesians, in the context of nasolabial anthropometry.

The primary objective of this study was to provide nasolabial anthropometric measurements in non-cleft infants, serving as an initial guide for nasolabial corrective surgery, including cleft lip procedures. Additionally, the study aimed to observe the effects of growth on these measurements.

MATERIALS AND METHODS

Study Population

Due to the limitation in accessible three dimensional (3D) image capture or surface scanners in our facility, a study of 3D morphology of infant facial soft tissue using retrospective Computed Tomography (CT) scan reconstructed images was the only non-invasive way.

Eight hundred and two retrospective CT images of patients were extracted from the archive of Radiology Department, Hasan Sadikin Hospital Bandung Indonesia, which were captured using SOMATOM Definition DS dual source 128 (Siemens, Erlangen, Germany) between 2019-2020. The population of this study consisted of East Asian ancestry.

The Research Ethics Committee Universitas Padjadjaran granted ethical exemption for this study (477/UN6.KEP/EC/2020).

Inclusion and exclusion criteria

Head CT images of 128 children were extracted from the hospital radiology archive. Age of the infants were calculated by comparing the date of birth and the date of the image taken.

After careful selection of children under 5 years old with a clear view of nasolabial soft tissue structure, 36 images were pooled. Children with facial dysmorphic and disrupted nasolabial structure due to medical instruments were excluded. The samples were divided into two age groups: 0-12 months and 25-54 months.

3D CT-Scan reconstruction

The CT machine produced images in the form of Digital Imaging and Communications in Medicine (DICOM) files. InVesalius 3.1, an open source 3D reconstruction software, rendered the head CT slices and transformed the images into 3D craniofacial skeletons (Center for Information Technology Renato Archer (CTI), Campinas - São Paulo, Brazil). Subsequently, the software rendered the soft tissue resulting in a 3D craniofacial surface.

Data Collection and Analysis

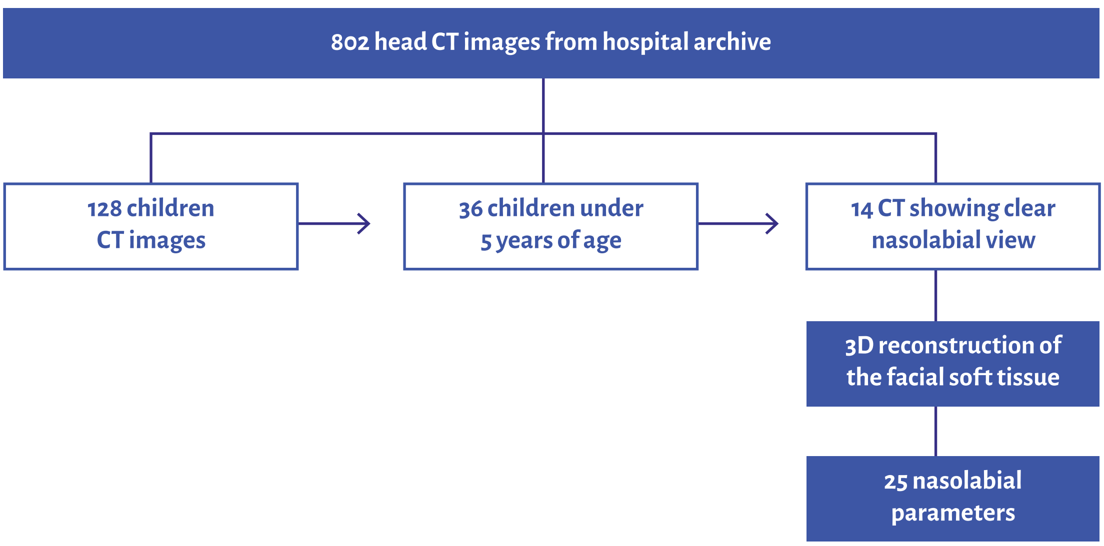
Twenty-five nasolabial parameters as previously described by Thomas *et al.*,[7] were measured using the ruler tool in InVesalius and then recorded to a spreadsheet by two blinded observers (Table 1; Figure 1 and Figure 2). SPSS (Statistical Program for Social Sciences, version 26; SPSS Inc., Chicago, IL, USA) statistical software was utilized for descriptive statistical analysis.

RESULTS

Only 14 children under 5 years old met the inclusion criteria, due to most of the patients having a cannula placed over the nasolabial structure, in which eight infants fell within the 0-12 months group and six children fell within the 25-54 months group. All subjects were of East Asian ancestry.

The linear variables were measured in 3 dimensional condition where rotational movement of the CT-based head model was enabled to inspect whether the landmark positioning is correct.

Figure 1. Flowchart of sample collection and methodology.



Descriptive statistics of nasolabial anthropo-metric measurements were tabulated (Table 2). Overall variables showed increasing dimension with pro-gressing age, in which the greatest in-crease were Hemilabial Length (Ch-Cphi; 4.8 mm - 5.6 mm) and Hemilabial' Length (Ch-Ls; 4.8 mm - 5.4 mm).

A Pearson correlation was run to determine the relationship between age and the linear mea-surement of nasolabial variables. There were moderate to strong, positive cor-relation between age and all nasolabial linear me-asurements, which were statistically significant (p<.05) except for nasal length, nares circumference, columella width, su-perior philtrum width, philtrum column height, and cutaneous upper lip height (Table 2).

Figure 2. Anthropometric landmarks measured in 3D rendered CT reconstruction.

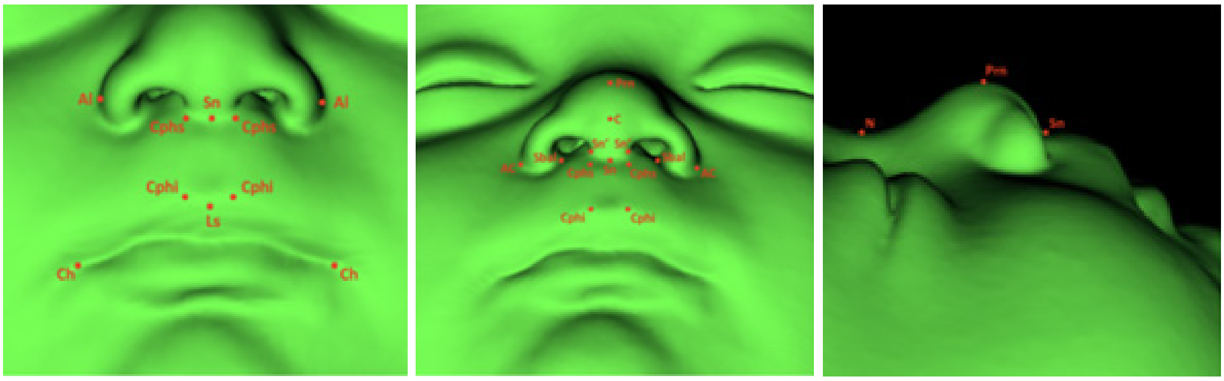


Table 1. Nasolabial anthropometric measurements.

Measurement	Definition	Abbreviation
Nasal Length	N-Prn	NL
Nasal Tip Protrusion	Sn-Prn	NTP
Nose Width (interalar width)	Al-Al	NW
Alar Base Width (right)	AC-C	ABW right
Alar Base Width (left)	AC-C	ABW left
Alar Length (right)	AC-Prn	AL right
Alar Length (left)	AC-Prn	AL left
Ala Thickness (right)	Sbal-AC	AT right
Ala Thickness (left)	Sbal-AC	AT left
Nares Circumference	Circumference of nares	NC
Columella Width	Sn'-Sn'	CW
Columella Length	Sn-C	CL
Sill Width (right)	Sn'-Sbal	SW right
Sill Width (left)	Sn'-Sbal	SW left
Superior Philtrum Width	Cphs-CPhs	SPW
Philtrum Width	Cphi-Cphi	PCW
Philtrum Column Height (right)	Cphi-Cphs	PCH right
Philtrum Column Height (left)	Cphi-Cphs	PCH left
Cutaneous Upper Lip Height	Ls-Sn	ULH
Mouth Width	Ch-Ch	MW
Nasolabial Length (right)	Ch-AC	NLL right
Nasolabial Length (left)	Ch-AC	NLL left
Hemilabial Length (right)	Ch-Cphi	HL right
Hemilabial Length (left)	Ch-Cphi	HL left
Hemilabial' Length (right)	Ch-Ls	HLL right
Hemilabial' Length (left)	Ch-Ls	HLL left

Table 2. Average measurements (in mm) of nasolabial landmarks. (Parameters are described in Table 1).

Parameter	0-12 months Min	Max	Mean	SD	25-54 months Min	Max	Mean	SD	Δ Mean	Pearson Correlation	Sig. (2-tailed)
Age (months)	0.5	11	4.6	3.7	25	54	36.5	11.5	- -	- - -	0.089
NL	11.7	18.8	16.2	2.2	13.8	22.9	18.5	3.7	2.3	- - -	0.025
NTP	8.6	13	10.5	1.4	9.5	14.9	12.1	1.9	1.6	.596*	0.006
NW	22.7	29.8	25.4	2.4	25.1	33.6	28.1	3.2	2.8	.692**	0.0
ABW right	14	17.9	15.7	1.5	16.5	21.5	18.8	2.1	3.1	.850**	0.001
ABW left	14.1	18.1	15.8	1.6	16	21.1	18.6	2.2	2.8	.780**	0.0
AL right	14.9	19.3	16.7	1.5	17.4	22.6	20	2	3.3	.861**	0.001
AL left	15.5	19.2	17	1.5	17.2	22.3	19.9	2.1	3	.784**	0.005
AT right	5.1	6.4	5.6	0.5	5.4	8.1	6.8	1.2	1.1	.730**	0.024
AT left	5.1	7.2	5.8	0.8	5.3	7.7	6.8	1.1	1	.598*	0.117
NC	13.1	22.9	18.5	3	15.1	27	21.2	4.4	2.7	- - -	0.089
CW	4.5	7.4	5.9	0.9	6.3	7.4	6.6	0.5	0.7	- - -	0.028
CL	6	11.4	8.4	1.5	8.7	11.7	9.8	1.1	1.4	.584*	0.04
SW right	3.1	5.6	4.3	0.9	4.1	6.1	5.2	0.7	0.9	.553*	0.007
SW left	3.2	5.4	4.4	0.7	4.2	6.4	5.3	0.8	0.9	.684**	0.076
SPW	3.4	9.7	6.1	1.8	6.3	8.1	7.2	0.7	1.1	- - -	0.014
PCW	4.6	9.5	6.4	1.6	6.6	9.2	8.1	0.9	1.7	.640*	0.341
PCH right	7.7	9.4	8.6	0.6	7.2	10	9	1	0.4	- - -	0.664
PCH left	7.8	9.6	8.6	0.7	7.3	10.1	8.8	0.9	0.2	- - -	0.245
ULH	8.6	10.6	9.3	0.7	7.7	12.4	10.1	1.6	0.7	- - -	0.034
MW	20.7	31.7	27.2	3.9	25.9	36.7	31	3.7	3.9	.569*	0.001
NLL right	15.2	17.6	16.5	0.9	15.8	26.8	21	4	4.5	.783**	0.0
NLL left	14.4	18	16.4	1.1	16.4	27.6	21.2	4	4.8	.814**	0.002
HL right	12.7	17	15.3	1.3	14.6	28	20.1	4.7	4.8	.758**	0.001
HL left	12.7	15.9	14.9	1	14.4	30	20.5	5.3	5.6	.769**	0.005
HLL right	13.8	19.8	17.3	1.7	16.8	30.7	22.1	5	4.8	.708**	0.001
HLL left	14.2	19	17.2	1.6	17.1	31.9	22.6	5.2	5.4	.772**	0.089

:** Pearson Correlation is significant at the 0.05 level (2-tailed). *:** Pearson Correlation is significant at the 0.01 level (2-tailed).
SD: Standard deviation.

DISCUSSION

Orofacial clefts deformities result in asymmetry in the nasolabial region, as well as asymmetries in dentition, affecting both the position and number of teeth, as well as the space in the alveolar process.[13-15] Not only unilateral OFC, but bilateral OFC also present asymmetry due to rotation of the anterior part of the alveolar bone.[13]

The present study focused on the nasolabial anthropometric structures in non-OFC children, which may support clinicians in replicating linear measurements according to the children's age. This study extracted CT images at a hospital in West Java Indonesia which is primarily populated by people of East Asian ancestry. Therefore, a variety of East Asian sub-ancestral groups may have formed the study sample.[16,17] This study filled the gaps of the previous studies in

Table 3. Comparison of nasolabial average measurements (in mm) between different ancestry groups (*Thomas et al, 2013; †Jodeh et al, 2021; ‡Yamada et al, 2002; §This study). (Parameters are described in Table 1).

Age	8.7 month			3-8 month			4 month	2-11 month	25-54 month
Ethnicity	Black*	Hispanic*	White*	Black†	Hispanic†	White†	Japanese East Asian‡	Indonesian§	East Asian§
Technique	Plaster molds			3D photographs using handheld camera			3D surface scanner	3D recon-structed	CT images
Sample size	6	9	17	10	7	16	97	8	6
NL	17.8	20	18.9					16.2	18.5
NTP	11	12.4	12.2	12.1	11.4	11.4		10.5	12.1
NW	30.5	27.7	26.4	29.3	25.1	24.0	26.6	25.4	28.1
ABW right	16.3	17.3	15.5					15.7	18.8
ABW left								15.8	18.6
AL right	20.2	20.3	19.4					16.7	20
AL left								17	19.9
AT right	3.7	3.7	3.6					5.6	6.8
AT left								5.8	6.8
NC	20.8	18.9	20.6					18.5	21.2
CW	6.3	6	6					5.9	6.6
CL	5	5.6	5.3	5.5	4.8	5.0		8.4	9.8
SW right	6.9	7.1	7.4					4.3	5.2
SW left								4.4	5.3
SPW	8.1	7.5	7.7	4.9	4.7	4.8		6.1	7.2
PCW	10.2	9	8.5	7.8	6.5	5.6		6.4	8.1
PCH right	11.4	11	8.9	12.1	9.8	11.5		8.6	9
PCH left				12.0	9.8	11.7		8.6	8.8
ULH	12.7	12.2	9.8	12.7	10.2	11.7		9.3	10.1
MW	33.8	32.4	33.5				27.91	27.2	31
NLL right	12.5	22.5	21.1				18.36	16.5	21
NLL left								16.4	21.2
HL right	12.7	20.1	21	19.1	17.3	17.6	16.8	15.3	20.1
HL left				18.6	18.5	18.7		14.9	20.5
HLL right	33.8	23.2	24					17.3	22.1
HLL left								17.2	22.6

normal nasolabial anthropometrics which were primarily presenting African American, Hispanic, and European descents as the study sample.[7]

Two studies in 2013 and 2021 compared the nasolabial morphology of 3 ethnicities of African American, Hispanic, and European ancestry groups.[7,10] The current study complemented these previous studies by providing East Asian subjects, a different ancestry group to the literature. Jodeh *et al.*,[10] found that African American infants showed wider noses and longer lips compared to Hispanic and European ancestry groups. These findings suggested a different approach should be undertaken when designing rhinoplasty and surgical repair plan.[7,10].

Overall, the parameters recorded in this study showed increasing measurements from 0-12 months infants to 25-54 months children except for philtrum column height (both sides) and upper lip height which showed slight decrease. The study found a statistically significant, moderate to strong positive correlation between age groups and nasolabial linear measurements. This finding is clinically important, as it indicates that nasolabial structures grow with age.

Consequently, the linear anthropometric measurements provided can guide surgeons in achieving optimal aesthetic results in nasolabial re-construction. There was an age gap between two subject groups (13-24 months). However, this was unintentional and reflected the natural composition of patients in the archive. We gathered previous published data of nasolabial anthropometric studies (Table 3). Four studies in nasolabial morphology were conducted using different approaches: plaster molds, 3D photographs using handheld camera, 3D surface scanners, and 3D reconstructed CT images. The utilization of the 3D imaging system is the gold standard for nasolabial anthropome-tric quantitative study.[18]

The ability of the instruments of a quick capture time, high-accuracy within 1 mm, simple procedure in acquiring 3D structure, low cost, and minimal exposure of unnecessary radiation are the vital factors in choosing the imaging technique.[6] This study realized the limited options of instruments of choice in the current research environment.

CT archives can be utilized for craniofacial anthropometric studies by 3D rendering of both skeletal and soft tissue structures. Therefore, 3D reconstruction of CT scan images which were extracted from the hospital archive became the best option in these circumstances. Two previous studies presented nasolabial morphology of Black, Hispanic, and European infants.[7,10] Only one study presented East Asian infants.[19] The present study addressed the gaps by investigating a broader range of parameters compared to the previous East Asian nasolabial study. This study added reference to infant nasolabial anthropometry in the Indonesian population as a preliminary study for further research of cleft in the Indonesia region which was lacking in the literature.[20] One study combined the left and right sides measurements and two studies separated them. In this study it was decided to separate each side to show that there was slight asymmetry in nasolabial structures.

For future insight, should there be an appliance being developed to assist in maintaining the symmetry of the nose post-rhinoplasty, the appliance can be adjusted in size and shape following the natural nostril morphology of infants in the respective ancestry group. The fact that this study did not consider the weight of the patient lies as the limitation of this study due to the assumption that heavier babies tend to have larger craniofacial structures. The weight of the patients were not available in the imaging archive. Targeting children for facial an-thropometric study is challenging in terms of uncooperative subjects and the low number of participants.[7] The absence of an interobserver study remains a potential area for improvement in future research. Another limitation of this study is the absence of a sample size determination process. This fact was realized by the authors of this study which was shown by the low sample size. This was primarily due to the difficulty in acquiring samples of nasolabial structures in children without prior intervention.

However, the sample size of the current study is comparable with the previous study when pooled by ethnicity.[7,10] Therefore, this study may serve as a pilot study for infants of East Asian ancestry, the acquired data can be combined with the previous study for meta-analysis in the future research.

CONCLUSION

This study offers detailed anthropometric measurements of normal nasolabial morphology in infants and children, providing essential guidelines for nasolabial reconstructive surgeries in cases of congenital anomalies.

Moreover, these measurements establish a baseline for evaluating surgical outcomes in the Indonesian population within the East Asian ancestry group. Furthermore, nasolabial growth variations were observed, suggesting that the data should be utilized with care, particularly for the respective age groups.

CONFLICT OF INTERESTS

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

ETHICS APPROVAL

The Research Ethics Committee Universitas Padjadjaran granted ethical exemption for this study (477/UN6.KEP/EC/2020).

FUNDING

This study received financial support from the Universitas Padjadjaran Internal Research Grant (1959/UN6.3.1/PT.00/2021).

AUTHORS' CONTRIBUTIONS

Erli Sarilita: Conceptualization, formal analysis, investigation, methodology, resources, software, validation, writing – original draft.

Harry Galuh Nugraha: Data curation, methodology, resources, software, writing – original draft.

Nani Murniati: Investigation, writing – original draft, writing – original draft, writing – original draft.

Endang Sjamsudin: Conceptualization, Data curation,validation, writing – original draft.

Harmas Yazid Yusuf: Conceptualization, writing – original draft.

ACKNOWLEDGEMENTS

This study was carried out under the supervision of Oral Biomaterial Research Centre Universitas Padjadjaran. The authors would like to convey gratitude to the donors of the CT images. Gratitudes also extended to Restu Amelia, Bening Tyasa, and Mutiara Azzahra Rizandi for logistical support.

ORCID

Erli Sarilita
0000-0002-4678-2744
Harry Galuh Nugraha
0000-0002-5299-8808
Nani Murniati
0000-0001-8115-1545
Endang Sjamsudin
0000-0002-9669-6465
Harmas Yazid Yusuf
0000-0001-7970-1181

PUBLISHER'S NOTE

All statements expressed in this article are those of the authors alone and do not necessarily represent those of the publisher, editors, and reviewers.

PEER REVIEW

This manuscript was evaluated by the editors of the journal and reviewed by at least two peers in a double-blind process.

PLAGIARISM SOFTWARE

This manuscript was analyzed Compilatio pla-giarism detector software. Analysis report of document ID. cb5d93959f6b89ec1f6d77dd519bdc3dae84212c

ISSN Print 0719-2460 - ISSN Online 0719-2479.
https://www.joralres.com/index.php/JOralRes/issue/archive

REFERENCES.

1. Mossey PA, Little J, Munger RG, Dixon MJ, Shaw WC. Cleft lip and palate. The Lancet. 2009;374(9703):1773-85.

2. Nasroen SL, Maskoen AM, Soedjana H, Hilmanto D, Gani BA. IRF6 rs2235371 as a risk factor for non-syndromic cleft palate only among the Deutero-Malay race in Indonesia and its effect on the IRF6 mRNA expression level. Dental and Medical Problems. 2022;59(1):59-65.

3. Paradowska-Stolarz, A., Mikulewicz, M. and Duś-Ilnicka, I., 2022. Current concepts and challenges in the treatment of cleft lip and palate patients—A comprehensive review. Journal of Personalized Medicine, 12(12):2089.

4. Kadir A, Mossey PA, Orth M, Blencowe H, Sowmiya M, Lawn JE, Mastroiacovo P, Modell B. Systematic review and meta-analysis of the birth prevalence of orofacial clefts in low-and middle-income countries. Cleft Palate Craniofac J. 2017 Sep;54(5):571-81.

5. Yamanishi T, Kondo T, Kirikoshi S, Otsuki K, Uematsu S, Nishio J. Morphological correlations in nasolabial formation after primary lip repair for unilateral cleft lip. J Oral Maxillofac Surg. 2021;79(10):2126-2133.

6. Ayoub A, Garrahy A, Hood C, White J, Bock M, Siebert JP, Spencer R, Ray A. Validation of a vision-based, three-dimensional facial imaging system. Cleft Palate Craniofac J. 2003;40(5):523–529.

7. Thomas MD, Pfaff MJ, Tonn J, Steinbacher DM. Normal nasolabial anatomy in infants younger than 1 year of age. Plast Reconstr Surg. 2013;131(4):574e-81e.

8. Al-Rudainy D, Ju X, Mehendale FV, Ayoub A. Longitudinal 3D assessment of facial asymmetry in unilateral cleft lip and palate. Cleft Palate Craniofac J. 2019;56(4):495-501.

9. Kurnik NM, Calis M, Sobol DL, Kapadia H, Mercan E, Raymond WT. A Comparative Assessment of Nasal Appearance following Nasoalveolar Molding and Primary Surgical Repair for Treatment of Unilateral Cleft Lip and Palate. Plastic and Reconstructive Surgery. 2021;148(5):1075-1084.

10. Jodeh DS, Ross JM, Leszczynska M, Qamar F, Dawkins RL, Cray JJ, Rottgers SA. Determination of Ethnic Variation in Infant Nasolabial Anthropometry Using 3D Photographs: Implications for Bilateral Cleft Lip Nasal Correction. Cleft Palate Craniofac J. 2021;59(6):693-700.

11. Loo YL, Van Slyke AC, Shanmuganathan P, Reitmaier R, Chong DK. A Guide to Bilateral Cleft Lip Markings: An Anthropometric Study of the Normal Cupid's Bow. Cleft Palate Craniofac J. 2021; 59(7):926-931

12. Jahanbin A, Emami A, Eslami N. Anthropometric Parameters of Nasomaxillary Complex in 2, 4, 6, and 12-Month-Old Children as a Reference for Cleft Lip and Palate Reconstructive Surgery. J Craniofac Surg. 2021;32(2):597-599.

13. Paradowska-Stolarz A, Kawala B. Dental anomalies in maxillary incisors and canines among patients with total cleft lip and palate. Appl Sci. 2023. 13(11):6635.

14. Paradowska-Stolarz AM, Kawala B. The nasolabial angle among patients with total cleft lip and palate. Adv Clin Exp Med. 2015. 24(3):481-5.

15. Ariawan D, Vitria EE, Sulistyani LD, Anindya CS, Adrin NS, Aini N, Hak MS. Prevalence of Simonart's band in cleft children at a cleft center in Indonesia: A nine-year retrospective study. Dent Med Probl. 2022. 1(59):509-15.

16. Sarilita E, Rynn C, Mossey PA, Black S, Oscandar F. Nose profile morphology and accuracy study of nose profile estimation method in Scottish subadult and Indonesian adult populations. Int J Legal Med. 2018;132(3):923-31.

17. Sarilita E, Rynn C, Mossey PA, Black S, Oscandar F. Facial average soft tissue depth variation based on skeletal classes in Indonesian adult population: A retrospective lateral cephalometric study. Leg Med. 2020;43:101665.

18. Ayoub A, Khan A, Aldhanhani A, Alnaser H, Naudi K, Ju X, Gillgrass T, Mossey P. The validation of an innovative method for 3D capture and analysis of the nasolabial region in cleft cases. Cleft Palate Craniofac J. 2021;58(1):98-104.

19. Yamada T, Mori Y, Minami K, Mishima K, Tsukamoto Y. Three-dimensional analysis of facial morphology in normal Japanese children as control data for cleft surgery. Cleft Palate Craniofac J. 2002;39(5):517-26.

20. Sarilita E, Setiawan AS, Mossey PA. Orofacial clefts in low-and middle-income countries: A scoping review of quality and quantity of research based on literature between 2010-2019. Orth Craniofac Res. 2021;24(3):421-9.