

Conversion Values of Vertical Dimension Occlusion Height to Length of Right Hand Fingers among Batak Toba Ethnic

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Abstract: Height of Vertical Dimension Occlusion is the vertical distance between maxilla and mandibula, measured at two anatomical points from Subnasal point on maxilla to Menton point on mandibula. VDO height can affect mastication, fonetic, and esthetic functions. The purpose of this study is to determine the conversion values of VDO height to length of right hand fingers among Batak Toba ethnic with Class I Angle Occlusion aged 19-25 years. Conversion of VDO to fingers method can be used for facial reconstruction during loss of VDO height. This study used a descriptive analytic method with cross-sectional design. The result of this study showed that there are no significant differences between every age ($p > 0,05$), there are significant differences between gender ($p < 0,05$) and significant differences between conversion values of VDO height to length of right hand fingers of male and female. The conclusions of this study are mean VDO value: $67,65 \pm 4,680$ mm, for males: $70,76 \pm 3,614$ mm, for females: $64,54 \pm 3,384$ mm, and conversion values of VDO height to length of index finger, little finger and distance from tip of thumb to tip of index finger of right hand for males: [$36.265 + (0,486 \times \text{length of index finger})$], [$52.428 + (0,291 \times \text{length of little finger})$], [$49.595 + (0,327 \times \text{distance from tip of thumb to tip of index finger})$] and for females : [$45.317 + (0,289 \times \text{length of index finger})$], [$63.442 + (0,019 \times \text{length of little finger})$], [$60.100 + (0,077 \times \text{distance from tip of thumb to tip of index finger})$].

Keyword: Vertical Dimension Occlusion, Conversion Values, Length of Fingers

I. Introduction

Vertical Dimension Occlusion (VDO) is the vertical distance between two anatomical points which are Subnasal (maxilla) to Menton (mandibular) where teeth of upper and lower jaws are in occlusion.^{1,2} The height of VDO depends on the length of ramus, gonial angle, tooth eruption, and Temporo Mandibular Joint (TMJ).² Growth and development factors such as nutrition, social economy, and genetic can affect the length of jaw bone and condition of teeth.^{1,2,3,4} Generally, the process of growth and development will end at the age of 18 whereby after this age, the jaw bone has achieved maximal length and will not continue growing.⁵ Odias RR (2008) has done a research regarding the facial height of Batak females in Medan, and the results showed 18.3576 cm with lower third of facial height of 6.4209 cm which is the height of VDO.^{6,7} This research is done on Batak ethnic generally without differentiating sub Batak ethnics which consists of Toba, Karo, Simalungun, Pakpak, and Mandailing, the type of occlusion was also not restricted (Angle's Class I, Class II, Class III).

The height of VDO can change into a higher or lower value than the normal height.^{1,4} an increase in VDO can be caused by high dentures and overfilling of tooth that impairs chewing, speech, and less appealing esthetic features, whereas decreased VDO can be caused by full edentulous, accidents, and severe attrition that reduces the strength of masticatory muscles, facial wrinkles, angular cheilitis, and impaired speech.^{2,6,7,8} Changes in VDO may impair masticatory, phonetic, and esthetic functions, therefore a method is needed to be used as a guide in reconstructing the lower third of facial height.

Ruchi Ladda (2012) from India has carried out a research about the conversion of VDO to length of right hand digits on Indians aged 20-30 years old. There was a significant and positive relationship between VDO and all the parameters that were measured, which is length of index finger, little finger, and distance from the tip of thumb to the tip of index finger. Conversion values of VDO to right hand digits that were obtained from Indian males were VDO= [$31.123 + (0.423 \times \text{Length of index finger})$], VDO= [$33.075 + (0.461 \times \text{Length of little finger})$], VDO= [$42.568 + (0.235 \times \text{Distance from the tip of thumb to the tip of index finger})$], for females VDO= [$42.162 + (0.235 \times \text{Length of index finger})$], VDO= [$35.167 + (0.382 \times \text{Length of little finger})$], VDO= [$48.228 + (0.152 \times \text{Distance from the tip of thumb to the tip of index finger})$]. This method can be used as a guide for Indians.¹

Based on the description above, there are researches regarding measurement of normal VDO and conversion of normal VDO to length of fingers and because this research has not been done in Medan city, therefore a research about conversion values of VDO to length of right hand digits is to be done on Batak Toba ethnic aged 19-25 years old with Angle's Class I Occlusion.

II. Materials And Methods

This is an analytic descriptive research with cross-sectional design by measuring the VDO of Batak Toba ethnic aged 19-25 years old. Datas on VDO and conversion values of VDO to right index finger, little finger and distance from the tip of thumb to the tip of index finger were obtained.

The instrument to measure VDO and length of fingers used in this research is a modified Eee brand digital caliper with 0.01 mm accuracy. The samples in this research were 70 subjects which are divided into 35 males and 35 females and further divided into sub age groups with 5 samples in each group according to the inclusion and exclusion criteria. The inclusion criteria for VDO measurement were complete set of 28 teeth from right second molar to left second molar on the maxilla and mandibular, two generations of Batak Toba ethnic, aged 19 -25 years old, Angle's Class I Occlusion, the exclusion criterias were anterior open bite, attrition not more than 1/3 of incisal/ occlusal, traumatic occlusion, is having or has a history of temporomandibular joint disorder, a history of facial trauma, undergone orthodontic treatment, undergone orthognathic surgery, and deep bite. Whereas inclusion criterias for finger length measurement were complete right hand fingers and without anomalies, and the exclusion criteria was having undergone operation on the palm of hand.

In order to obtain VDO measurements, the subjects were first seated on a chair that was prepared and the position of head at a right angle to the floor, relaxed without expression, mouth closed and teeth in occlusion. VDO was measured from subnasal point at the base of the nose to menton point at the enc of the chin (points were drawn parallel to the median line) (Figure 1). Hereafter, the length of digits were measured on the right index finger, little finger, and distance from the tip of thumb to the tip of index finger where the palm of hand was in a supine position on the table. Measurement of index finger starts from the tip of finger to the point closest to MP joint crease digiti II (Metacarpo-Phalangeal crease) (Figure 2). Measurement of little finger starts from the tip of finger to the point furthest from MP jjoint crease digiti V (Metacarpo-Phalangeal crease) (Figure 3). For measurement of distance between the tip of thumb to the tip of index finger, the thumb is positioned close to the index finger, then the tip of thumb was marked on the index finger with a pen. The distance between the tip of index finger to the tip of thumb was then measured (Figure 4).



Figure 1. Measurement of vertical dimension occlusion



Figure 2. Measurement of length of index finger



Figure 3. Measurement of length of little finger



Figure 4. Measurement of the distance from the tip of thumb to the tip of index finger

III. Results

The results of ANOVA test on VDO of Batak Toba ethnic with Angle's Class I Occlusion aged 19-25 years old does not show any significant difference of VDO between each age groups which is from age 19-25 years old ($p > 0.05$).

Table 1. Average VDO of Batak Toba ethnic with Angle's Class I Occlusion in age groups 19-25 years old

Age (Year)	VDO mean (mm)	Max (mm)	Min (mm)	SD (mm)	$\bar{x} \pm SD$ (mm)	P
19	67,16	79,87	59,78	5,590	67,65 ± 4,680	0,995
20	68,49	76,86	62,44	4,947		
21	67,66	74,08	60,30	5,047		
22	67,67	74,47	59,65	4,796		
23	67,60	76,34	61,62	4,777		
24	68,03	72,53	58,24	4,610		
25	66,95	72,44	59,27	4,229		

*Oneway Anova Test, *significant $p < 0,05$*

Unpaired t-test on VDO of Batak Toba ethnic with Angle's Class I Occlusion aged 19-25 years old showed a significant difference of VDO height where VDO of males were higher than that of females ($p < 0.05$).

Table 2. VDO of Batak Toba ethnic with Angle's Class I Occlusion aged 19-25 years old between males and females

Group	VDO (mm)		Max (mm)	Min (mm)	P
	N	$\bar{x} \pm SD$			
Male	35	70,76 ± 3,614	79,87	63,37	0,0001*
Female	35	64,54 ± 3,384	72,35	58,24	

*Unpaire T Test, *significant $p < 0,05$*

Linear regression test between VDO and length of right hand digits which are index finger, little finger, and distance from the tip of thumb to the tip of index finger obtained a regression equation with the formula $y = a + bx$ (Figures 5 to 10). Regression results are shown on Table 3.

Table 3. Regression analysis between VDO of Batak Toba ethnic with Angle's Class I Occlusion aged 19-25 years old males and females, and length of index finger, little finger, and distance from the tip of thumb to the tip of index finger

Sex	Variabel Dependent	Variabel Independent	Regression Equation	R ² (%)	SE
Male & Female	VDO	A	$Y=21,816+0,667xA$	0,370	3,742
		B	$Y=37,702+0,496xB$	0,242	4,104
		C	$Y=34,614+0,539xC$	0,358	3,778
Male	VDO	A	$Y=36.265+0,486xA$	0,255	3.166
		B	$Y=52.428+0,291xB$	0,107	3.466
		C	$Y=49.595+0,327xC$	0,147	3.389
Female	VDO	A	$Y=45.317+0,289xA$	0,095	3.269
		B	$Y=63.442+0,019xB$	0,000	3.434
		C	$Y=60.100+0,077xC$	0,005	3.426

Linear Regression Test

Y= Height of VDO

A= Length of index finger

B= Length of little finger

C= Distance from the tip of thumb to the tip of index finger

Unpaire t-test showed no significant difference between average values of VDO conversion and length of index finger, little finger, and distance from the tip of thumb to the tip of index finger for males and females in age group 19-25 years old ($p < 0.05$).

Table 4. Conversion values of VDO of Batak Toba ethnic with Angle's Class I Occlusion to length of right index finger in age groups 19-25 years old in males and females

Right Finger	Age (Year)	Conversion value of male's VDO (mm)	SD (mm)	Conversion value of female's VDO (mm)	SD (mm)	P
Index finger	19-25	70,73	1,824	64,76	1,362	0,0001*
Little finger	19-25	70,56	1,567	64,53	0,701	0,0001*
Distance from the tip of thumb to the tip of index finger	19-25	70,58	1,710	64,53	0,254	0,0001*

Unpaire T test, *significant $p < 0,05$

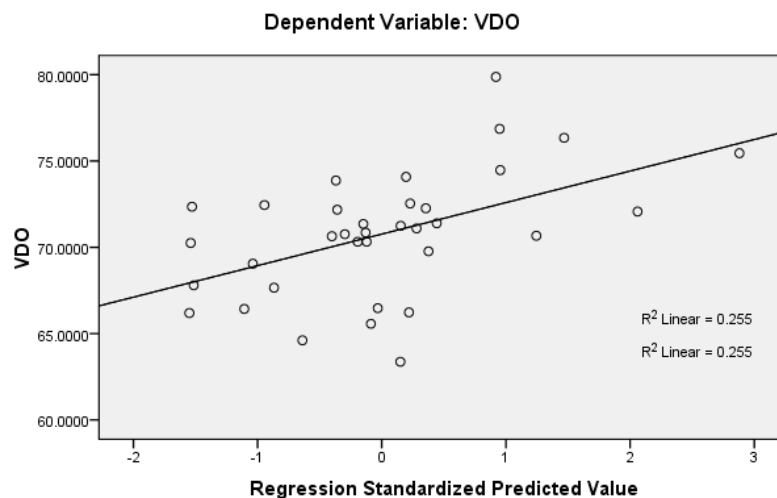


Figure 5. Diagram of linear regression of VDO with length of index finger in males

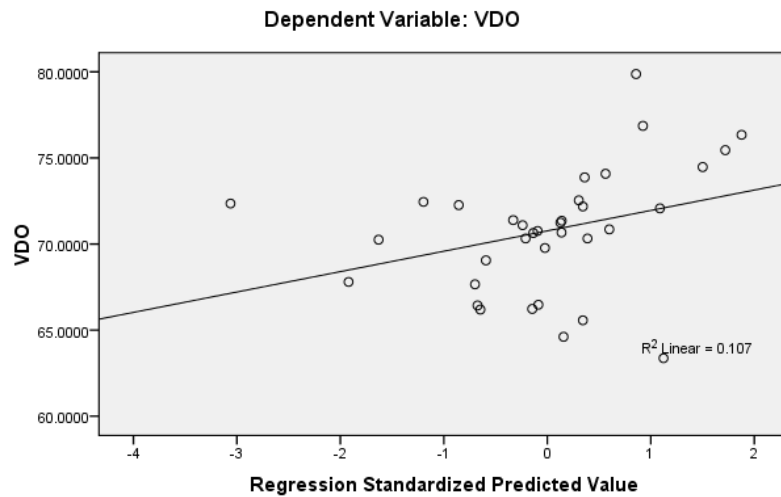


Figure 6. Diagram of linear regression of VDO with length of little finger in males

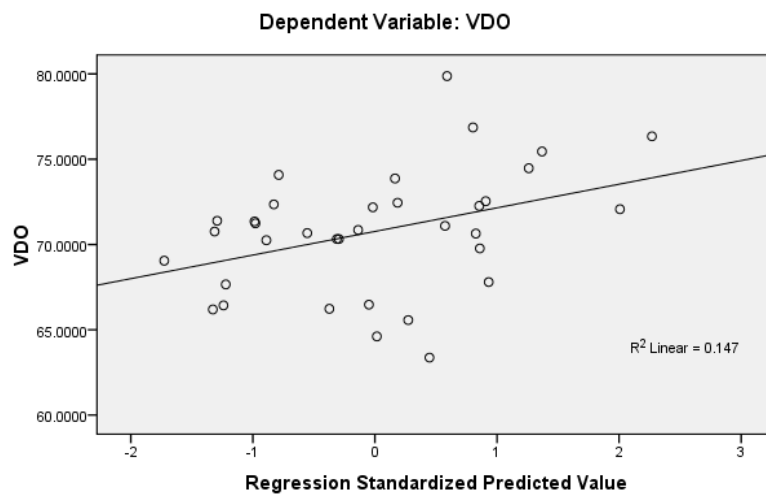


Figure 7. Diagram of linear regression of VDO with distance from the tip of thumb to the tip of index finger in males

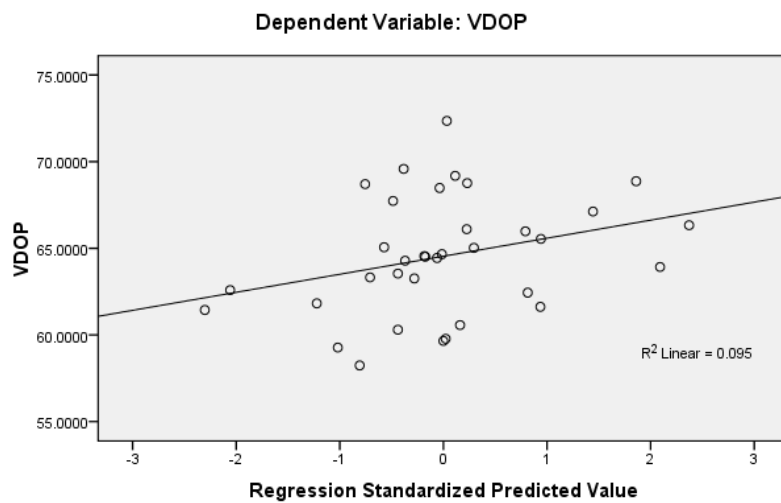


Figure 8. Diagram of linear regression of VDO with length of index finger in females

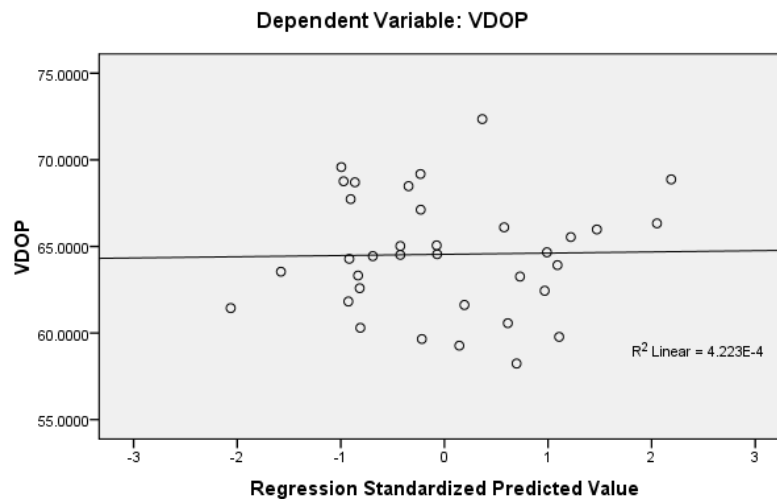


Figure 9. Diagram of linear regression of VDO with length of little finger in females

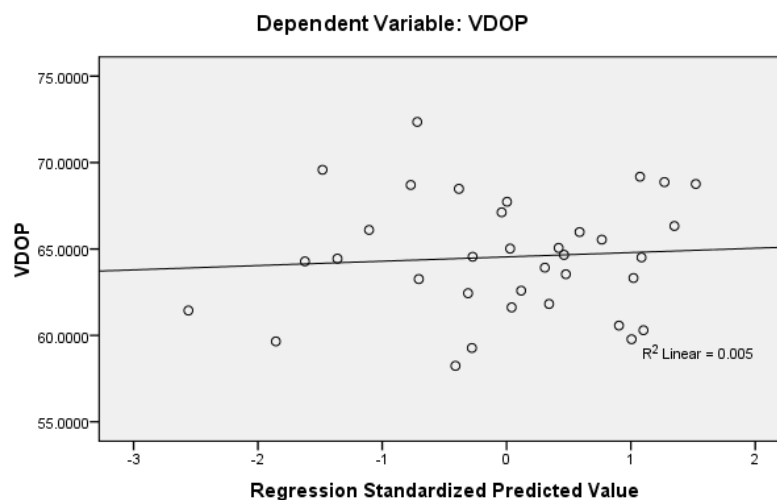


Figure 10. Diagram of linear regression of VDO with distance from the tip of thumb to the tip of index finger in females

IV. Discussion

VDO is included in a part of facial height, which is the lower third of the face where it is measured from subnasal point to menton with all the teeth in occluded position.⁸ VDO can be affected by tooth eruption, TMJ, gonial angle, and length of mandibular ramus.² The aforementioned factors are affected by race, nutritional intake, gender, and types of food intake during growth and developmental period.^{1,2,3,4} VDO will achieve its maximum height when the process of growth and development is complete. Generally this process will end at age 18-19 years old for males and 16-17 years old for females in western population.⁹ Data regarding the end of growth and development process for males and females in Indonesia, especially in Batak Toba ethnic has yet to be achieved.

According to the results of this research, VDO of Batak Toba ethnic with Angle's Class I Occlusion in age group 19-25 years old was 67.65 ± 4.689 mm. Compared to VDO measurement by Basnet (2015) on Mongoloids (64.60 ± 4.48 mm) and Aryans (67.94 ± 5.02 mm) in Nepal,¹⁰ and also research done by Rassol (2007) in Iraq (68.40 ± 2.9 mm)¹¹, the results of this research were in the same range as the researches done by Basnet and Rassol. In this research, analysis of VDO of Batak Toba ethnic with Angle's Class I Occlusion in age group 19-25 years old was done with OnewayAnova test (Table 2), and the results showed no significant difference between each age group which is from 19 to 25 years old ($p=0.995$), where VDO for ages 19, 20, 21, 22, 23, 24 and 25 were all in the same range. According to theory, the process of growth and development stops at age 18,⁹ which explains the age group chosen for this research, which is students with Batak Toba ethnicity aged above 18 to 25 years old. Hence, there were no significant difference of VDO between ages 19-25 years old.

According to Hauspie (2010), the body measurements of males are larger than females, which includes length, width, height, and weight.^{3,4,9} This is due to genetic, environmental, nutritional factors, types of food and physical activities. The results of this research (Table 3) analysed with unpaired t-test showed that VDO of males aged 19-25 years old (70.76 ± 3.614 mm) is significantly larger than that of females (64.54 ± 3.384 mm) ($p < 0.05$). This result is consistent with the research done by RuchiLada on 400 Indians for VDO measurement of males (61.3 ± 4.266 mm) which is more than the VDO of females (56.7 ± 3.008 mm).¹

If changes of VDO occurs, for example caused by accident, attrition or prolonged tooth loss, VDO has to be restored with existing methods. Various methods can be used to restore VDO, and one of them is by converting VDO to length of right hand digits. Measurements of digits were used as parameters for restoring VDO because there is a significant relationship between VDO and the length of fingers (index finger, little finger, and distance between tip of thumb to tip of index finger) ($p < 0.05$). Moreover, this method is usually chosen because the instruments used are simpler, measurements can be taken easily, economically friendly, comfortable, and does not need radiography.¹

Based on the results of this research (Table 3), the conversion values of VDO to length of right hand digits in our research samples were obtained, where regression equation of VDO to length of index finger : $[21.816 + (0.667 \times \text{Length of index finger})]$, in males $[36.265 + (0.486 \times \text{Length of index finger})]$, in females $[45.317 + (0.289 \times \text{Length of index finger})]$, VDO to length of little finger $[37.702 + (0.496 \times \text{Length of little finger})]$, in males $[52.428 + (0.291 \times \text{Length of little finger})]$, in females $[63.442 + (0.019 \times \text{Length of little finger})]$, VDO to distance from the tip of thumb to the tip of index finger $[34.614 + (0.539 \times \text{Distance from the tip of thumb to the tip of index finger})]$, in males $[36.265 + (0.486 \times \text{Distance from the tip of thumb to the tip of index finger})]$, in females $[45.317 + (0.289 \times \text{Distance from the tip of thumb to the tip of index finger})]$. Unpaired t-test analysis (Table 4) showed that the conversion values of VDO to length of index finger, little finger, and distance from the tip of thumb to the tip of index finger in males were larger than females ($p < 0.05$). This is due to androgen hormones which alters the growth and development of the body that are shown through larger jaw bone measurement and fingers of males were also larger than females.^{1,11}

From the results of this research, further studies are needed with more samples so that the results are more accurate which can be used in practices. Further studies on conversion values of VDO to length of right hand digits need to be carried out on Batak Toba ethnic.

The conclusions of this study are average VDO: 67.65 ± 4.689 mm, in males: 70.76 ± 3.614 mm, in females: 64.54 ± 3.384 mm. Conversion values of VDO to length of index finger, little finger and distance between tip of thumb to tip of index finger in males: $[36.265 + (0.486 \times \text{Length of index finger})]$, $[52.428 + (0.291 \times \text{Length of little finger})]$, $[36.265 + (0.486 \times \text{Distance from the tip of thumb to the tip of index finger})]$, whereas in females: $[45.317 + (0.289 \times \text{Length of index finger})]$, $[63.442 + (0.019 \times \text{Length of little finger})]$, and females $[45.317 + (0.289 \times \text{Distance from the tip of thumb to the tip of index finger})]$.

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