



ORIGINAL ARTICLE

Reliability of anthropological measurements in determining vertical dimension of occlusion in Saudi population: A cross sectional study



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KEYWORDS

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Abstract *Background:* Range of techniques have been described in traditional prosthodontics to establish Vertical dimension of occlusion (VDO). Experienced clinicians agree that there is no one single method, which is universally accepted record VDO precisely and consistently. Many facial and body landmarks have been proposed in the literature correlating to the VDO. Presence of so many methods to determine VDO further leads to confusion in the minds of clinicians. There is always a need for a research to both substantiate the findings in the literature and check reliability of such correlations in local population. Such correlation between the anthropological measurements and VDO would give clinician an evidence based approach to establish VDO during prosthetic rehabilitation. Hence this study was planned to check reliability of various anthropometric measurements in measuring VDO in a cross section of Saudi population.

Material and method: Total of 500 subjects selected for the study following an inclusion and exclusion criteria. Anthropological readings such as Index finger, Little finger, Thumb finger, Distance between Inner canthus of left eye to outer canthus of right eye and Outer canthus of the right eye to corner of mouth (rima oris) were recorded using digital Vernier caliper. The data were analyzed statistically.

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Results: Strong positive correlation was observed between VDO and anthropological landmarks selected in the study. Pearson's correlation test showed VDO in males has strong coefficient correlation with Index finger ($r = 0.7341$) and in females strong coefficient correlation with Little finger. ($r = 0.5827$).

Conclusion: In Saudi Males, VDO could be correlated to the index finger measurements followed by Thumb finger. In Saudi females subjects, VDO correlated with little finger measurements followed by outer canthus of the eye to corner of the mouth reading. It is always appropriate to use one or more methods to approximate the measurements of VDO initially and then use the other methods to test the appropriateness of the dimensions initially established.

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1. Introduction

Vertical dimension of occlusion (VDO) is one of the most important measurements required to be registered during the rehabilitation of completely edentulous patients and in patients who have lost vertical dimension due to severe wear of natural teeth and/or missing multiple posterior teeth. Determining the VDO forms the basis of prosthetic rehabilitation of such patients.

VDO refers to the length of the face as determined by the amount jaw separation. The Glossary of Prosthodontic Terms (GPT, 2017) defines vertical dimension as the distance between two selected anatomic or marked points [usually one on the tip of the nose and the other upon the chin], one on a fixed and one on a movable member. There are two components of vertical dimension. VDO refers to the vertical dimension when teeth are in contact. Vertical dimension at rest refers to the vertical dimension while the mandible is in a resting position independent of teeth contact. VDO is a more stable position and not influenced by gravity or head position and is therefore easier to record compared to vertical dimension at rest (Zarb and Bolender, 2004)

Range of techniques have been described in traditional prosthodontics to establish VDO. Subjective methods include the use of resting position of mandible, phonetics and esthetics, and patient perceived comfort (Atwood, 1966; Miljkovic et al., 2001; Millet et al., 2010; Silverman, 1953; Shanahan, 1956). Objective methods include the use of pre-extraction records, maximum biting force, electromyography method, cephalometric radiograph, and anthropological facial and body part measurements (Al-Hamdany and Kassab, 2010; Aruna, 2012; Boos, 1940; Bissasu, 2004; Ismail et al., 1968; Hurst, 1962; Ladda et al., 2013; McGee, 1947; McMillan and Imber, 1968; Nagpal et al., 2014; Strajnic et al., 2008).

Experienced clinicians agree that there is no one single method that is universally accepted to record VDO precisely and consistently. The subjective methods are difficult to master and require a certain level of clinical experience. Objective methods which use anthropological measurements from face or body parts can be used to determine occlusal vertical dimension in patients since they are accessible, easy to measure, and relatively constant throughout life.

Although many techniques exist for the evaluation of VDO, none of them is scientifically more accurate than another, and each method has its limitations. Finding a reliable method to determine the correct VDO has always been a challenge for the clinicians in the field of complete denture prosthodontics

The wide variety of methods to determine VDO leads to confusion among clinicians. There is always a need for a research to both substantiate the findings in the literature and check reliability of such correlations in local populations. Such correlation between the anthropological measurements and VDO would give clinicians an evidence-based approach to establish VDO during prosthetic rehabilitation. Hence, this study was planned to check the reliability of various anthropometric measurements in measuring VDO in a cross-section of the Saudi population.

2. Material and methods

This cross-sectional study was planned in Ibn Sina National College for medical studies (Dental outpatient clinic) in Jeddah, Saudi Arabia. The research proposal was formulated according to institutional guidelines and necessary ethical clearance from institutional ethical committee was obtained (001DP03092019). All the subjects who participated in the research were informed about the study and the nature of measurements that would be taken. Written informed consent was obtained. All the anthropometric measurements were recorded clinically using a digital Vernier caliper with an accuracy of 0.01 mm.

A total of 500 subjects participated in the study. Inclusion criteria for the subjects participating in the study was framed accordingly. Subjects selected were of either sex, with no particular age range, no history of orthodontic treatment, having at least 28 periodontally sound teeth in proper Class I occlusion. Subjects with missing teeth, supra eruptions or physiologic or pathologic migrations, deep bite, open bite, severe attrition/wear, extensive extra-coronal restorations, such as crowns and bridge work, and patients with temporomandibular joint disorders were excluded from the study. As the study involved taking readings from face and fingers, any patient with facial deformity, history of oral and maxillofacial trauma cases, and hand deformities were also excluded from the study.

For this study, the following anthropological readings from the face and hands were selected.

1. Base of the nose to inferior of the chin reading as shown in Fig. 1A was considered as VDO reading.
2. Outer canthus of the right eye to corner of mouth (rima oris) (OCCM) reading as shown in Fig. 1B
3. Inner canthus of left eye to outer canthus of right eye reading (ICOC) as shown in Fig. 1C
4. Index finger (IF) as shown in Fig. 1D
5. Thumb finger (TF) as shown in Fig. 1E

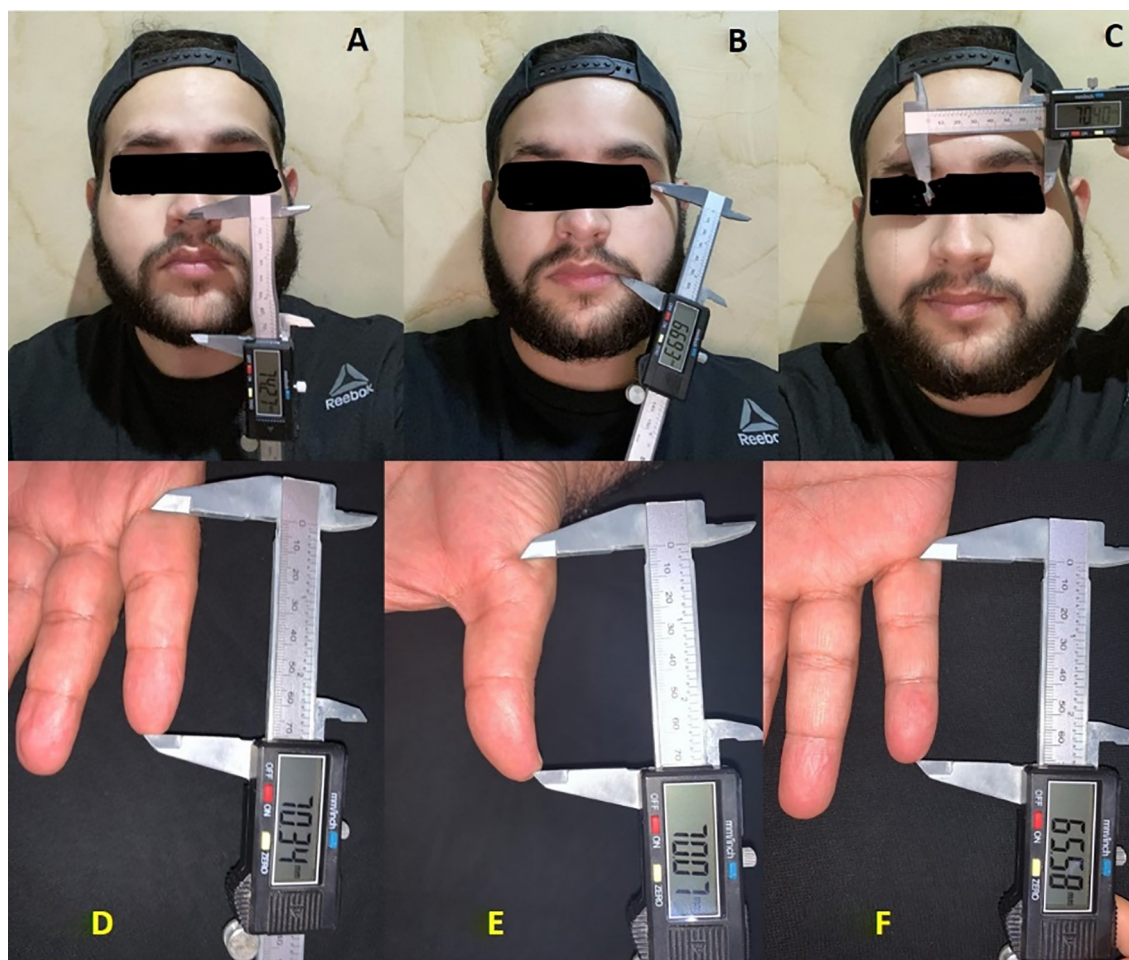


Fig. 1 Facial measurements and finger measurements.

6. Little finger (LF) as shown in Fig. 1F

All the readings were recorded in the dental clinic, with the patient seated comfortably in the dental chair. Patient's head was straight and unsupported, with the mandible parallel to the ground. Patient was asked to bite lightly on his/her posterior teeth with lips in competent/repose position.

VDO measurements were made as follows. The lower tip of a Vernier caliper was placed firmly against the chin, making sure the end of Vernier caliper touched the lower border of mandible in chin area, and the upper end of Vernier caliper was raised until it lightly touched the skin at the base of the nose. Other facial measurements, such as inner canthus to outer canthus of the eye and outer canthus to rima oris were taken as shown in Fig. 1A–C.

Readings from the patient's hand were taken as follows. (Length of the index finger, little finger, and thumb). Patient was asked to keep the hand in a supine/palmer position. Digital Vernier caliper readings were taken from the tip of the finger to the nearest finger crease as shown in Figure (1D, 1E, 1F). An average of 3 readings were taken in all the measurements. The data obtained was statistically analyzed using SPSS version 22.

3. Results:

A total 500 subjects were screened including 260 females and 240 males. The age group ranged from 18 to 55 years. The distribution of subjects participating the study, according to gender and age group can be seen in Table 1.

Table 1 Distribution of respondents by age group and gender.

Age groups	Male	Percentage	Female	Percentage	Total	Percentage
18-27yrs	177	51.91	164	48.09	341	68.20
28-37yrs	51	44.74	63	55.26	114	22.80
> = 38yrs	12	26.67	33	73.33	45	9.00
Mean age	26.57		28.11		27.37	
SD age	5.82		8.67		7.47	
Total	240	48.00	260	52.00	500	100.00

An independent-samples *t*-test was conducted to compare readings between different parameters for male and female subjects [Table 2](#). There was significant difference in all the parameters at p -value ≤ 0.001 . These results suggest that gender has a significant effect on the VDO readings. Male subjects showed higher VDO values when compared to females.

A Pearson correlation coefficient was computed to assess the relationship between VDO reading and other anthropological readings ([Table 3](#)). There was a strong positive correlation “*r*” value ranging from 0.49 to 0.73, $p = < 0.001$ for male and female subjects.

In males, index finger measurements were very closely related to the VDO dimension readings ($r = 0.7341$, $p = < 0.001$) when compared with other anthropological parameters selected in the study. The least correlation was observed between VDO dimension readings and outer canthus to corner of the mouth/rima oris readings ($r = 0.6097$, $p \leq 0.001$) ([Fig. 2](#)), whereas in females, measurements of the little finger were closely related to VDO dimension readings ($r = 0.5827$, $p \leq 0.001$). The least correlation was observed between VDO dimension readings and index finger readings ($r = 0.4945$, $p \leq 0.001$) ([Fig. 3](#)).

4. Discussion

In the absence of pre-extraction records establishing correct vertical dimension of occlusion is challenging to the dentist.

“Clinical judgement” continues to play a major role in the assessment of this important component in the construction of complete dentures ([Nagpal et al., 2014](#)). Because of the subjectivity involved in decision making, many dentists face difficulties in determining correct VDO, especially when rehabilitating fully edentulous patients or patients who no longer have stable tooth contact.

Anthropometric measurements are used because they are stable landmarks and do not change over the natural aging cycle. These readings are specific to the patient and are easily repeated. There was a scarcity of data in the Saudi population. Hence, the objective of the study was to investigate the reliability of anthropological measurements cited in the literature to VDO in the Saudi population.

McGee ([McGee, 1947](#)) correlated the known VDO with three facial measurements. The three measurements are: the distance from the center of the pupil of the eye to a line projected laterally from the median line of the lips; the distance from the glabella to the subnasion; and the distance between the angles of the mouth with the lips in repose. He found that in 95% of his subjects with natural teeth, two or three of these measurements corresponded to the vertical dimension of occlusion.

Results of our study are in accordance with the cross-sectional study conducted by [Ladda et al., \(2013\)](#) on 400 dentate subjects comprised of 200 males and 200 females comparing anthropometric measurements of VDO, length of index finger, length of little finger, and distance from tip of thumb

Table 2 Comparison of males and females with mean score of different parameters by independent t-test.

Parameters	Male		Female		t-value	p-value
	Mean	SD	Mean	SD		
VDO (Base of nose-lower border of chin)	68.16	6.24	61.18	7.40	11.3607	< 0.001
Index finger	68.61	5.54	66.09	4.93	5.3645	< 0.001
Little finger	62.47	6.23	57.00	6.23	9.8069	< 0.001
Thumb finger	64.39	6.23	58.29	7.74	9.6570	< 0.001
Inner canthus of eye to outer canthus of eye on other side	68.48	5.82	65.56	5.27	5.8993	< 0.001
Outer canthus of eye to corner of mouth	68.67	7.06	65.76	6.09	4.9442	< 0.001

In males, the mean of VDO dimension measurements was 68.16 mm with a standard deviation of 6.24 mm. In females, the mean of VDO dimension measurements was 61.18 mm, with a standard deviation of 7.40 mm. T-test for equality revealed that there was significant difference between measurements of VDO for males and females ($t = 11.3607$, p -value: ≤ 0.001). When Male and female observations were compared, a statistically significant difference was observed at 5% level of significance, indicating the males had significantly higher values than females in all the observed readings.

Table 3 Correlations between bases of nose-lower border of chin (VDO) with other parameters by Karl Pearson’s correlation coefficient method.

Parameters	Correlation between VDO (Base of nose-lower border of chin)					
	Total samples (n = 500)		Male samples (n = 240)		Female samples (n = 260)	
	r-value	p-value	r-value	p-value	r-value	p-value
Index finger (IF)	0.6260	< 0.001	0.7341	< 0.001	0.4945	< 0.001
Little finger (LF)	0.6934	< 0.001	0.6870	< 0.001	0.5827	< 0.001
Thumb finger (TF)	0.6674	< 0.001	0.6874	< 0.001	0.5385	< 0.001
Inner canthus of eye to outer canthus of eye on other side (ICOC)	0.6288	< 0.001	0.6556	< 0.001	0.5534	< 0.001
Outer canthus of eye to corner of mouth (OCCM)	0.5869	< 0.001	0.6097	< 0.001	0.5321	< 0.001

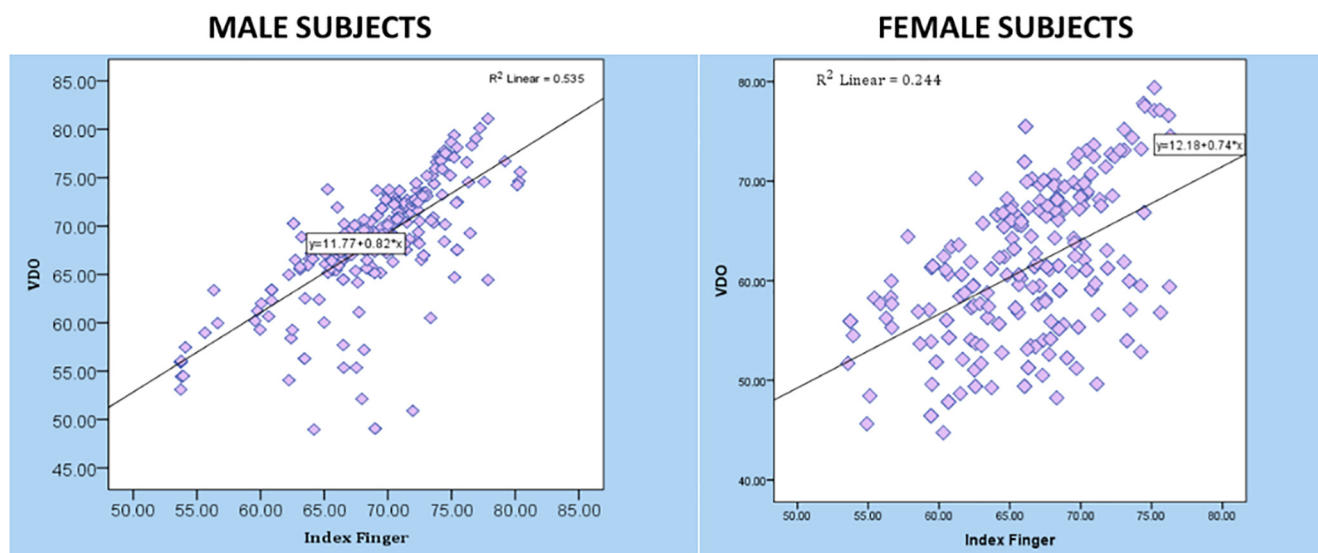


Fig. 2 Scatter plot diagram showing the correlations between VDO (base of nose-lower border of chin) and index finger in male and female subjects.

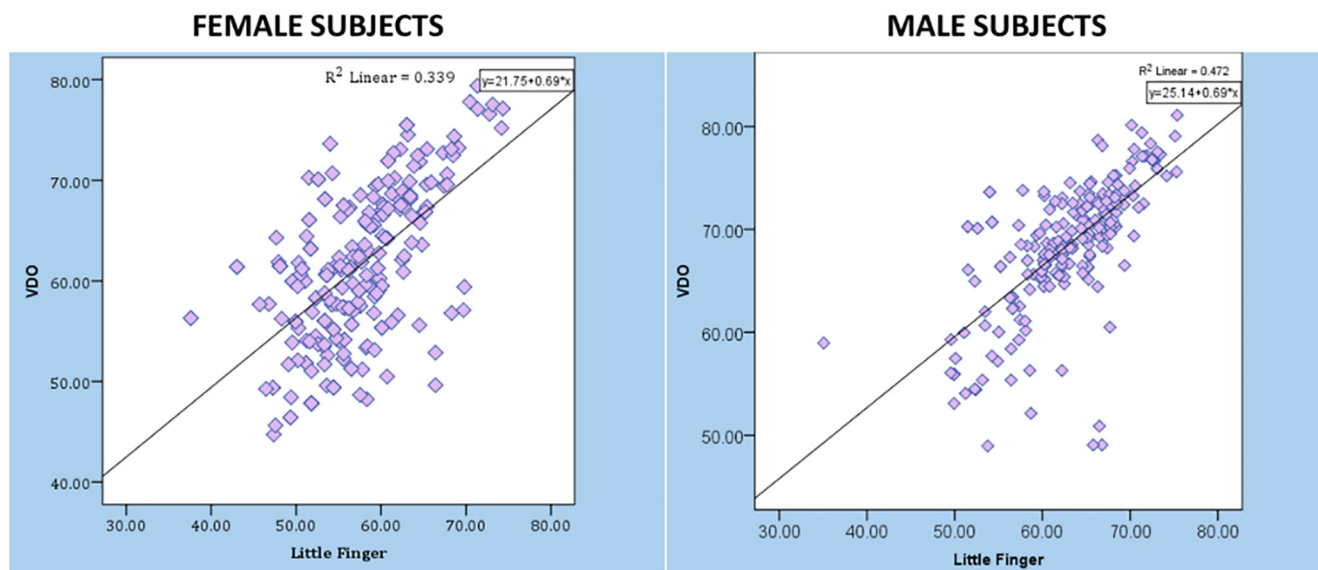


Fig. 3 Scatter plot diagram showing the correlations between VDO (base of nose-lower border of chin) and little finger in female and male subjects.

to tip of index finger of the right hand. They reported that VDO was significantly and positively correlated with all the parameters studied. In males, correlation of VDO was strongest for length of index finger ($r=0.406$), whereas in females, it was strongest for length of little finger ($r=0.385$).

Hussain and Yazdanie (2019) studied the correlation between VDO and index finger in 250 subjects (166 female and 84 male). They found significant correlation between VDO and index finger in both male and female subjects. ($r = 0.74$ and $r = 0.82$ respectively, $p = 0.000$). However, in our study, we found significant correlation between VDO and index finger only in males and not in female participants ($r = 0.7341$, $p = 0.001$).

In our study, the VDO measurement taken from the base of the nose to lower border of chin was least correlated to outer canthus of eye to rima oris measurement. Similar findings were reported by Alhaji et al., (2016) in their study. They also reported that when the VDO measurements were taken from tip of the nose to the base of the chin, there was strong correlation between VDO measurement and outer canthus of eye to rima oris measurement.

Differences in measuring techniques, ethnicities of the population, and sample size studied can lead to slight variations in the readings. The results of our study of the VDO of Saudi people clearly indicated positive correlation with various anthropological readings in the study. In Saudi male subjects, the VDO could be correlated to the index finger measurements

followed by thumb measurements. In Saudi female subjects, VDO correlated with little finger measurements followed by outer canthus of the eye to corner of the mouth reading.

The results of this study and many other similar studies cited in the literature indicate that anthropometric measurements, such as finger lengths and other facial measurements can serve as a basic guide in estimating the VDO and offer significant prosthetic advantages. The objective nature of these methods eliminates the guess work involved in subjective methods to determine VDO such as resting jaw position or swallowing. VDO estimated using anthropometric readings is within the range of 2–4 mm which is significantly less than other methods, where a range of 0–14 mm is given (Atwood, 1966; Silverman, 1953). An anthropometric method to determine VDO is attractive and practical because it is simple, economic, non-invasive, and reliable. They do not require radiographs or sophisticated measuring devices and provide reproducible values for future reference. These methods do not require a great amount of time and experience to master.

Some of the limitations of the study may be due to smaller sample size, inclusion of only subjects Class I malocclusion. Authors also agree regarding the difficulty in the taking facial readings, especially in subjects with excessive soft tissue bulk under the chin. However, to further substantiate the findings, authors recommend similar analysis to be carried out in bigger sample size and different ethnic groups.

Authors agree with Ladda et al. (2013), that the operator should keep in mind that VDO is the result of a musculoskeletal balance. The correct VDO can be better described as a range instead of a fixed point. Therefore, to evaluate the VDO, a pluralistic method should be adopted at all the stages of rehabilitation to maximize the benefits and minimize damage to the stomatognathic system. Regardless of the technique, the vertical dimension of occlusion must be determined carefully by the dentist for a successful prosthesis

5. Conclusion

Based on the results of our study, in Saudi male subjects, the VDO could be correlated to the index finger measurements and in Saudi female subjects, VDO correlated with little finger measurements. As none of the methods to determine VDO can be used independently and reliably, it is appropriate to use one or more methods to approximate the measurements of VDO initially and then use the other methods to test the appropriateness of the dimensions initially established.

Ethical statement

Hereby state that this is original work carried out by us at Ibn Sina National College for medical studies, Jeddah, Saudi Arabia under the approval of institutional ethical committee.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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