The effect of nutritional status on mesiodistal and bucco/ lingual or palatal diameters of permanent teeth among fifteen years old students

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ABSTRACT

Background: Malnutrition during human growth affects the size of the tissues at different stages of life, body proportions, body chemistry, as well as quality and texture of tissues. Teeth are particularly sensitive to malnutrition. Malnutrition may affect odontometric measurement involving tooth size dimensions. The aim of this study was to estimate the effect of nutrition on teeth size dimension measurements among students aged 15 years old.

Materials and methods: This study was conducted among malnourished group in comparison to well-nourished group matching with age and gender. The present study included 167 students aged 15 years (83 malnourished and 84 well-nourished). The assessment of nutritional status was done by using body mass index (BMI). Odontometric measurements included three different orientations. For both upper and lower study models, photographs were taken using special photographic apparatus for each student, and the data were then analyzed using special computer software. For permanent dentitions, two linear measurements (mesiodistal and bucco \lingual or palatal) were utilized, representing tooth diameters for each tooth.

Results: Among students aged 15 years, the findings revealed that all means of mesiodistal and bucco-lingual diameters values of maxillary and mandibular teeth were lower among malnourished than well-nourished groups with statistically significant, except for mesiodistal diameters of both second molar, second and first premolar of maxillary teeth, second premolar, first premolar and lateral incisor of mandibular teeth and for bucco-palatal diameters of second and first premolar of maxillary teeth, second molar and lateral incisor of mandibular teeth.

Conclusion: Malnutrition effect on minimize the odontometric measurements (mesiodistal and bucco-lingual diameters) among students aged 15 years.

Keyword: Mesiodistal diameter, bucco-lingual diameter, bucco-palatal diameter, permanent teeth. (J Bagh Coll Dentistry 2016; 28(2):108-114).

INTRODUCTION

Nutrition is the provision of adequate energy and nutrients to the cells for them to perform adequate physical and social activities, and maintains or enhances its healthy state [(1)]. Malnutrition can be defined as a “pathological state resulting from absolute or relative deficiency or excess of one or more of the essential nutrients" [(2)]. Still malnutrition is one of the global highest priority health issues not only as its effects are so widespread and long lasting but also because it can be eradicated [(3)].

The dental plaster models of a patient's dentition are necessary in dental measurement [(4)]. Recently, dentistry looks to digital archive and tend to be paperless patient information systems. Especially when many methods have been used to determine and to analyze dental plaster casts [(5)].

This is one of the reasons to use photograph technique to measure dimension of dental cast in this study. Protein Energy Malnutrition might responsible for the decrease in tooth diameters [(6)].

This study represents the pioneering aspect. It's importance in terms of providing greater visibility to the harmful effects of malnutrition on oral pictures and change dental morphometric.

MATERIALS AND METHODS

The sample collection

The collection of sample in present study involved age group 15 years with different nutritional status. Age was recorded according to the last birthday [(7)]. Out of 220 who were initially examined, only 167 students (83 malnourished and 84 well-nourished) were candidates selected for the morphometeric analysis in this study. The pupil should not suffer from any serious systemic disease or health problem as indicated by the schools’ records, all permanent teeth were erupted, with exception of the third molar [(8)].

The students should be free from: congenital abnormalities, congenital missing teeth, supernumerary or abnormal shape tooth and clinical signs of attrition and enamel defect.

Instruments and supplies

Plane mouth dental mirror (No. 4), sickle shape explorer (No.00), bathroom scale for recording weight, The height of the individuals was measured by using the ordinary height measuring tape, electric vibrator (Quale Dental),

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dental vernier (Dentaurum 0.05 mm (042-751) Germany, digital Camera (6 Mega pixels) Sony, photographic apparatus (Figure 1), software Auto Cad, 2006, product version Z.54.10.

Classification of nutritional status of students aged 15 years

Body Mass Index: This index was used to determine the nutritional status of persons aged 15 years. The index represents a number that is calculated from weight and height according to the following formula:

$$\textbf{BMI} = \frac{\textbf{Weight (Kg)}}{\textbf{Height (meter)}^2}$$

In present study, the cut-off point of BMI at SD below -2 was used to determine the person as malnourished, the SD between median and below +1 for well-nourished

Morphometric measurements

Photographic technique and Cast orientation

The three-dimension analysis of crown orientation was achieved by considering the three rotational axes of pitch, roll and yaw [(9,10)]. The three rotational axes introduced into the systematic description of dentofacial traits significantly improved the precision to descript tooth orientation which included crown angulation and inclination.

The crown orientations represent the reference to classify each dental arch into three segments according the occlusal views (one anterior, right posterior and left posterior) to measure mesiodistal and bucco-lingual diameters of the tooth crown. Tooth diameters measurements permit by capturing with photographic technique depending on these three views for each arch. Before image acquisition, the cast should be oriented until incisal surfaces or occlusal surfaces of specific dental segment are orthogonal to the optical axis of the camera for each captures.

This procedure was performed by putting the dental cast in surveyor base, and the cusp tips of specific segment teeth were reflected by the highest points. Cast orientation was done through the rotation through which the four sides of the tooth should be well defined. The next step of orientation would be restrained by balancing the movements in the three axes (x, y and z)(define above). The incisal or occlusal view of crowns for each segment was standardized by visually maximizing the visibility of the crown's sides (buccal, lingual, mesial, and distal) in away that it could measure tooth bucco-lingual and mesio-distal diameters (note: it is necessary to use the same orientation system for each dental typology). For each arch, four image captures were taken to three different cast orientations involving: anterior incisal segment, right and left posterior occlusal segments and occlusal surfaces of whole arch. These three photograph capture views of cast were produced as:

a) The posterior occlusal segment (right or/and left) views were standardized depending on overlap **line A** that represented the occclusal line of four posterior teeth and the index point* that should be located between second premolar and first molar for permanent dentition **(**Line A is a line that present on translucent horizontal plate).
b) The anterior incisal segment view was standardized according to overlap **line B** which represented the occlusal line of six anterior teeth and the index point ***** that should be located between right and left central incisor for permanent dentition (Line B is a line that present on translucent horizontal plate).

A reference metric system: prepare a metric scale in position parallel to and at the same level of the incisal and /or occlusal surface of cast (for each capture). By means of this metric scale, the calibration of each image dimension could be prepared. It was used to give a real metric value of the cast measurement by obtaining hypothetical factory and multiplying it with an initial measurement value of the photograph cast.

Final real (Actual) value = hypothetical factor * initial measurement value**.**

§ **Taking dental cast captures**

After identifying landmark and orientation of each dental cast, the dental cast was placed on the portable part of surveyor and oriented in an ideal way (Cusps heights were not used to orient the cast segment). Before taking a picture (in order to calibrate the image through suitable software), it is necessary to set a reference millimetric scale in correspondence to the occlusal surface of the tooth.

§ **Measurement of dental cast**

Dental cast measurements were made directly on upper and lower dental casts by photographic technique through photographic apparatus which provides a constant distance between digital camera and occlusal teeth surfaces through the plastic plate for standardization. Each set of dental casts were measured to the nearest 0.001 mm. Mesiodistal width is measured between two anatomical contact points (the greatest width from the anatomic mesial contact point to the distal one). Bucco-lingual measurement is the maximum diameter of the crown and perpendicular to the mesiodistal diameter [11,12].

All data analyses were performed using the SPSS statistical software programme (version 10 for Windows, SPSS). The confidence level was accepted at the level of 5%.

***Index point** is that point formed by crossing of two line (A,B), and it mark on the translucent horizontal plate to standardized the cast segment for capture, as it represent the point through which optical axis of camera pass

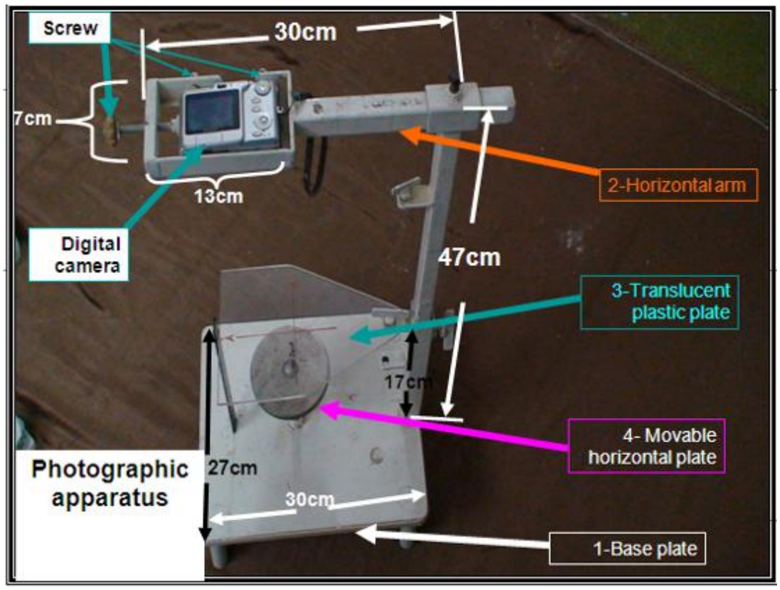

Fig. 1: Photographic Apparatus [13]

RESULTS

For permanent dentition, an initial analysis was made where tooth diameters (mesiodistal and/or bucco-lingual diameter) were calculated for right and left sides separately. Result found no significant difference between mean tooth diameter of right and left sides for all tooth categories (P>0.05). All subsequent statistical analysis were carried out on pooled data of right and left side measurements.

Table (1) illustrates the measurement of mesiodistal diameters of maxillary teeth in malnourished group and well-nourished among students aged 15 years. Concerning the maxillary teeth, data reported that the mean values of first molars, canine and central incisor diameters among malnourished group were highly significantly lower than well-nourished group (P< 0.01). Result observed that the mean values of lateral incisor diameters among malnourished group were significant lower than well-nourished (P< 0.05). Result observed that the mean values for both second molar, second and first premolar diameters among malnourished group were lower than well-nourished, with no significant difference (P> 0.05).

Table (2) illustrates the measurement of mesiodistal diameters of mandibular teeth in malnourished group and well-nourished of students aged 15 years. Concerning the mandibular teeth, result found that the mean values of first molars and canine diameters among malnourished group were highly significantly lower than well-nourished group (P< 0.01). Result observed that the mean values of second molar and central incisor diameters among malnourished group were significant lower than well-nourished (P< 0.05). Result observed that the mean values for second premolar, first premolar and lateral incisor diameters among malnourished group were lower than well-nourished, with no significant difference (P> 0.05).

Table (3) illustrates the measurement of bucco-palatal diameters of maxillary teeth in malnourished group and well-nourished among students aged 15 years. Concerning maxillary teeth, data showed that the mean values for maxillary second molar, first molar, canine and central incisor diameters among malnourished group were highly significantly lower than well-nourished group(P< 0.01). Result observed that the mean values of lateral incisor diameters among malnourished group were significant lower than well-nourished (P< 0.05). Result reported that the mean values for second and first premolar diameter among malnourished group were lower than well-nourished, with no significant difference (P >0.05).

The measurement of bucco-lingual diameters of mandibular teeth in malnourished group and well-nourished among students aged 15 years are shown in **Table (4).** Concerning the mandibular teeth, data showed that the mean value for first molar diameters among malnourished group were highly significantly lower than well-nourished group (P< 0.01). Result observed that the mean values of second premolar, first premolar, canine and central incisor diameters among malnourished group were significant lower than well-nourished (P< 0.05). Result observed that the mean values for second molar and lateral incisor diameters among malnourished group were lower than well-nourished, with no significant difference (P>0.05).

Table 1: Measurement of mesiodistal diameters (mm) of maxillary teeth in malnourished and well-nourished group among adolescent aged 15 years by gender

Tooth	Malnourished			Well-nourished			Statistical differences	
	No.	Mean	±SD	No.	Mean	±SD	Z -value	P-value
Right maxillary second molar	83	9.391	0.478	84	9.496	0.438	-1.762	0.078
Right maxillary first molar	83	9.636	0.56	84	10.36	0.526	-7.767**	0
Right maxillary second premolar	83	7.021	0.55	84	7.086	0.53	-0.763	0.445
Right maxillary first premolar	83	6.97	0.373	84	7.062	0.375	-1.767	0.077
Right maxillary canine	83	7.578	0.687	84	7.903	0.805	-3.034**	0.002
Right maxillary lateral incisor	83	6.458	0.69	84	6.673	0.707	-2.177*	0.03
Right maxillary central incisor	83	8.018	0.616	84	8.525	0.636	-5.051**	0
Left maxillary second molar	83	9.369	0.506	84	9.522	0.482	-1.887	0.059
Left maxillary first molar	83	9.603	0.583	84	10.326	0.551	-7.612**	0
Left maxillary second premolar	83	7.009	0.525	84	7.064	0.552	-0.986	0.324
Left maxillary first premolar	83	6.924	0.401	84	7.035	0.413	-1.892	0.059
Left maxillary canine	83	7.541	0.693	84	7.809	0.855	-2.742**	0.006
Left maxillary lateral incisor	83	6.436	0.695	84	6.657	0.707	-2.037*	0.042
Left maxillary central incisor	83	7.994	0.632	84	8.498	0.659	-4.846**	0

***P< 0.05, ** P<0.01**

Table 2: Measurement of mesiodistal diameters (mm) of mandibular teeth in malnourished and well-nourished group among adolescent aged 15 years by gender

Tooth	Malnourished			Well-nourished			Statistical differences	
	No.	Mean	±SD	No.	Mean	±SD	Z -value	P-value
Right mandibular second molar	83	9.751	0.635	84	9.97	0.628	-2.313*	0.021
Right mandibular first molar	83	10.303	0.496	84	11.045	0.516	-7.700**	0
Right mandibular second premolar	83	7.06	0.428	84	7.139	0.458	-1.853	0.064
Right mandibular first premolar	83	6.798	0.413	84	6.919	0.397	-1.887	0.059
Right mandibular canine	83	6.641	0.536	84	6.866	0.843	-5.602**	0
Right mandibular lateral incisor	83	6.162	0.559	84	6.282	0.543	-1.397	0.162
Right mandibular central incisor	83	5.326	0.573	84	5.532	0.561	-2.303*	0.021
Left mandibular second molar	83	9.714	0.664	84	9.949	0.659	-2.415*	0.016
Left mandibular first molar	83	10.263	0.534	84	11.003	0.553	-7.293**	0
Left mandibular second premolar	83	7.008	0.461	84	7.124	0.487	-1.762	0.078
Left mandibular first premolar	83	6.72	0.446	84	6.855	0.45	-1.913	0.056
Left mandibular canine	83	6.606	0.556	84	6.872	0.593	-2.642**	0.008
Left mandibular lateral incisor	83	6.141	0.562	84	6.266	0.545	-1.557	0.119
Left mandibular central incisor	83	5.222	0.567	84	5.443	0.57	-2.481*	0.013

***P< 0.05, ** P<0.01**

DISCUSSION

This study was conducted to assess the effects of malnutrition, on the oral health condition which include odontometric measurements and to compare these with the control group with similar characteristics to the study group except for the factor under investigation: therefore, the control group in the present study included well-nourished subjects who possess as much similarity as possible in terms of age, gender, social structure and geographic position. The 15 years index age was selected in the present study: this age is considered a critical human life stage which has recorded the past and present history of malnutrition and oral health conditions [14].

Table 3: Measurement of bucco-palatal diameters (mm) of maxillary teeth in malnourished and well-nourished group among adolescent aged 15 years by gender

Tooth	Malnourished			Well-nourished			Statistical differences	
	No.	Mean	±SD	No.	Mean	±SD	Z -value	P-value
Right maxillary second molar	83	10.062	0.541	84	11.702	0.576	-10.717**	0
Right maxillary first molar	83	10.019	0.368	84	10.327	0.345	-5.073**	0
Right maxillary second premolar	83	8.347	0.394	84	8.436	0.405	-1.666	0.096
Right maxillary first premolar	83	8.327	0.312	84	8.375	0.315	-0.964	0.335
Right maxillary canine	83	7.179	0.442	84	7.568	0.469	-5.421**	0
Right maxillary lateral incisor	83	5.829	0.505	84	6.036	0.513	-2.532*	0.011
Right maxillary central incisor	83	6.582	0.518	84	6.949	0.531	-4.203**	0
Left maxillary second molar	83	9.889	0.654	84	11.709	0.616	-10.571**	0
Left maxillary first molar	83	9.791	0.489	84	10.321	0.411	-6.674**	0
Left maxillary second premolar	83	8.313	0.415	84	8.427	0.431	-1.802	0.072
Left maxillary first premolar	83	8.303	0.353	84	8.332	0.348	-0.611	0.541
Left maxillary canine	83	7.065	0.488	84	7.583	0.485	-6.333**	0
Left maxillary lateral incisor	83	5.814	0.507	84	6.024	0.517	-2.486*	0.013
Left maxillary central incisor	83	6.572	0.519	84	6.925	0.535	-3.956**	0

***P< 0.05, ** P<0.01**

Table 4: Measurement of bucco-lingual diameters (mm) of mandibular teeth in malnourished and well-nourished group among adolescent aged 15 years by gender

Tooth	Malnourished			Well-nourished			Statistical differences	
	No.	Mean	±SD	No.	Mean	±SD	Z -value	P-value
Right mandibular second molar	83	9.491	0.428	84	9.578	0.479	-1.498	0.134
Right mandibular first molar	83	9.195	0.417	84	9.652	0.432	-5.822**	0
Right mandibular second premolar	83	7.625	0.396	84	7.781	0.405	-2.550*	0.011
Right mandibular first premolar	83	7.085	0.401	84	7.232	0.417	-2.566*	0.01
Right mandibular canine	83	6.725	0.46	84	6.9	0.494	-2.156*	0.031
Right mandibular lateral incisor	83	5.768	0.521	84	5.816	0.52	-0.996	0.319
Right mandibular central incisor	83	5.374	0.531	84	5.582	0.584	-2.193*	0.028
Left mandibular second molar	83	9.441	0.448	84	9.552	0.506	-1.692	0.091
Left mandibular first molar	83	9.129	0.448	84	9.602	0.474	-5.869**	0
Left mandibular second premolar	83	7.597	0.397	84	7.77	0.42	-2.495*	0.013
Left mandibular first premolar	83	7.056	0.429	84	7.201	0.449	-2.298*	0.022
Left mandibular canine	83	6.692	0.494	84	6.862	0.534	-2.074*	0.038
Left mandibular lateral incisor	83	5.681	0.513	84	5.726	0.522	-0.815	0.415
Left mandibular central incisor	83	5.347	0.545	84	5.561	0.6	-2.295*	0.022

***P< 0.05, ** P<0.01**

Moreover, the study was conducted among students aged 15 years to represent the permanent dentition stage, as teeth are considered to be full-size and within the appropriate normal time of complete eruption of all permanent teeth [15]. In addition, the 15 age group can represent a proper time for prediction of arch dimension and they are also considered as a static stage. Moreover, the complete eruption of permanent dentition is accomplished by the age of fifteen. Protein energy malnutrition was assessed in the present study by using Body Mass Index (BMI), and it was used to screen the weight categories according to WHO (2007), as an alternative to the use of the three indicators of nutritional status (height for age, weight for age and weight for height). BMI has been used to assess the size and growth pattern of individual, which indicate the relative posit ion of students' BMI in the growth table that showing the weight condition categories [16].

Furthermore, these measuring tools are simple and robust, and can be set up in any environment with non-invasive procedure. WHO (1995) [17] recommended using a -2SD cut off point which represents purely statistical separation of malnourished from well-nourished. Traditional casts were eliminated with the use of computer-aided diagnosis, particularly due to problems of storage in terms of space and cost, in addition to the risks of damage because of the brittle nature of dental cast. Therefore digital photography was used in this study. In the current study, it is obvious that the statistical analysis of tooth mean values of mesiodistal and bucco-lingual diameters in the upper and lower jaws revealed the absence of significant asymmetry between right and left sides for permanent dentition. These findings indicated that the measurements for the right or left sides represent the mesio-distal and bucco-lingual tooth diameters for this particular sample. This finding agreed with the usual practice that teeth on one side of the jaw, or the average of the two could be used for analyzing the teeth diameters [18]. This symmetrical may be attributed to the presence of similar genetic and environmental factors affecting the tooth size of teeth on the right and left sides. This particular finding is supported by other studies [17,18]. Similar finding was also reported in several Iraqi studies [15,19-21].

As for the mesiodistal and bucco-lingual diameters of the primary teeth among well-nourished, it is difficult to compare the data of present study with other studies. This may be due to differences in: the criteria of the sample selection and size; the methods used to determine tooth diameters; and the varying definitions of well-nourished group, as the previous studies might have included the different degrees of malnutrition. In general, there appears to be a clear relationship between a child's crown diameters and the mother's health during pregnancy, implying that their heritability included shared environmental as well as genetic factors. Some researchers reported that children submitted to a protein deficient diet during gestation and lactation might have their affect on dental development affected, whereas children with low birth weight condition have been observed to have small tooth size in deciduous dentition [22, 23].

Reduction of tooth size is thought to result from a decrease in the volume of dentin rather than a reduction enamel thickness [24] . Thus, it is conceivable that the influence of Protein Energy Malnutrition on tooth germs is different in the development period from that in a slightly later period. Although tooth crown morphology of deciduous dentition is determined predominantly in prenatal period and permanent teeth calcify post-natally. Some researchers observed that the pre-natal disturbances could lead to alteration of permanent teeth morphology to a degree as compared to that of deciduous teeth [25]. These explain the smaller mesiodistal and bucco-lingual diameters of permanent teeth among malnourished as compared to well-nourished groups in the present study. In case of improper weaning and during period precede tooth development, Protein Energy Malnutrition might disrupt environmental homeostasis during the advance stage of tooth formation and maturation, and the odontoblastic layer in this condition might be responsible for the apparent decrease in the diameter and density of the collagen fibrils of the intertubular dentin [6]. This proves the smaller mesiodistal and bucco-lingual tooth diameters among malnourished group in compare to well-nourished group for the permanent dentition.

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