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The Effect of Nutritional Status on Arch Width and Length of Permanent Teeth among Fifteen Years Old Students

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Abstract: ***Background**: At different stages of life, malnutrition could adversely affect various aspects of growth. Malnutrition may associated with decrease jaw height, as well as the reduced of the maxilla and mandible width. The aim of this study is to estimate the effect of nutritional status on arch width and length dimension measurements among students aged 15 years old. Material and methods: the sample of the present study include 167 students aged 15 years (83 malnourished and 84 well nourished).The assessment of nutritional status was done by using Body Mass Index (BMI).Odontometeric measurements including two different orientations. For both upper and lower study models, photographs were taken using special photographic apparatus, and the data were then analyzed using special computer software. For permanent dentitions,nine linear measurements were utilized for each dental arch including width and length measurements were utilized. Results: As for permanent dentitions, all means value of maxillary and mandible arch width, length and segments were lower among malnourished group than well-nourished group with statistically significant except for permanent maxillary anterior arch length, incisor-canine, mandibular inter-first premolar, anterior arch length. Conclusion: Malnutrition effect on minimize the odontometric measurements (dental arch width, dental arch length) among adolescents aged 15 years old.*

Keywords: Dental arch width, dental arch length , adolescents, malnourished

1. Introduction

Generally, nutrition represent as an essential needs of human beings and it provides human body with both energy and essential nutrients needed for adequate physical activitiyand healthy state (1). Malnutrition can be represent a pathological state resulting from deficiency or excess of one or more of the essential nutrients to the body" (2). Moreover, malnutrition may lead to craniofacial development problem. Both space limitations and nutrition play important role in the development of a healthy tooth germ and may be related to alterations shape and form of permanent teeth (3).

Plaster models of a patient's dentition are needed in dental measurement (4). Lately, dentistry looks to digital archive of dental cast and tend to be paperless patient information systems. Particularly when several methods have been used 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. Researchers confirmed that Protein-energy malnutrition is related with decrease jaw height (6), in addition to the reduced of both maxilla and mandible widths (7)

Generally, a number of anthropometric researches found a significant adverse effect of malnutrition on the growth and development of facial bones of adolescents, as well on the development of skeletal muscles and organs (8-9). This study represents the pioneering aspect. Its importance in terms of providing greater visibility to the negative effects of malnutrition on oral pictures and change dental arch morphometric.

2. 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 (9). 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 (10). 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), 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.

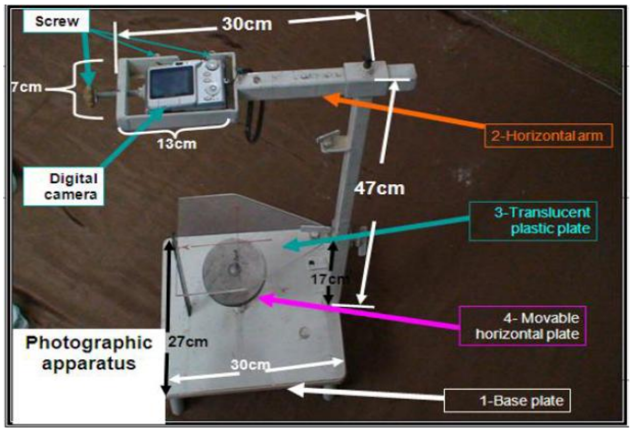

Figure 1: Photographic Apparatus (11)

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:

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

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

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 (12-13). One capture is sufficient for dental arch measurements. Before image acquisition, the cast should be oriented until incisal surfaces or occlusal surfaces of specific dental segment are orthogonal to theoptical axis of the camera for each captures. Thisprocedure was performed by putting the dental cast in surveyor base, and the cusp tips of specific segment teeth were reflected by the highest points. The next step of orientation would be restrained by balancing the movements in the three axes (x, y and z)(define above). For each arch, one image captures were taken to one cast occlusal surfaces orientations of whole arch. This photograph capture view of cast was produced as: Occlusal surfaces of whole arch view were standardized by overlapping of the two cross lines *(lines A and B) (where line A should overlap along the median palatal raphe of cast (MedianPalatal Line MPL) for the maxilla. In addition, the mirror image of MPL was transferred to the mandibular cast, and line B should overlap to transverse line that was tangent to the distal edge of the two second molars(namely right and left) for maxilla and mandible respectively).

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.

**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 represents the point through which optical axis of camera pass.*

Measurement of 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.

Post Capture   Pre Capture

Figure 2: The pre capture and post capture of dental cast for lower arch

Dental arch dimension

Dental arch width

a) **Inter-canine distance:** The linear distance from the cusp tip of right canine to the cusp tip of left canine (14 -17).
b) **Inter-premolar distance:** The linear distance from the buccal cusp tip of right second premolar to the buccal cusp tip of left second premolar.
c) **Inter-first molar distance:** The liner distance from the mesiobuccal cusp tip of right first molar to mesiobuccal cusp tip of left first molar (15-18).
d) **Inter-second molar distance:** The linear distance between the distobuccal cusp tip of right -second molar to the distobuccal cusp tip of left second molar (15,17).

Dental arch length

e) **Anterior arch length:** The vertical distance from the incisal point perpendicular to the inter canine distance at the cusp tips (17-18).
f) **Molar-vertical distance:** The vertical distance from the incisal point perpendicular to a line joining the mesiobuccal and/or mesiolingual cusp tips of the first molars (right and left) .
g) **Total arch length:** The vertical distance from the incisal point perpendicular to the line joining the distobuccal cusp tips of the second molars (15,17).

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%.

3. Results

The maxillary and mandibular dental arch width for malnourished group and well-nourished among students aged 15 years are shown in **Table (1)**. Concerning inter-canine distance, the mean value for maxilla inter-canine distance was found to be highly significant lower among malnourished group(32.782 ± 2.377 mm) than well-nourished group (33.834 ± 2.337 mm), with highly significant difference (P<0.01). The mean value for mandibular inter-canine distance was found to be significant lower among malnourished group(24.647 ± 4.017mm) than well-nourished group(25.504 ± 4.041mm) (P< 0.05). Concerning inter-first premolar distance, the mean values for maxillary inter-first premolar distance were found to be significant lower among malnourished group(39.102 ± 2.526 mm) than well-nourished group(40.083 ± 2.435mm) (P<0.05). In mandibule, the mean value for inter-first premolar distance was found to be lower among malnourished group(32.612± 2.266 mm) than well-nourished group(33.042± 2.395 mm), with no statistically significant difference (P > 0.05). Concerning inter-second premolar distance, the mean value for maxillary inter-second premolar distance was found to be highly significant lower among malnourished group(44.758±3.115mm) than well-nourished group(46.058 ± 3.073mm) (P<0.01). In mandibule, the mean value for inter-second premolar distance was found to be significant lower among malnourished group(39.209 ± 2.574mm) than well-nourished group(40.047 ± 2.526mm) (P<0.05). Concerning inter-first molar distance, the mean value for maxillary inter-first molar distance was found to be highly significant lower among malnourished group(50.127± 2.905mm) than well-nourished group(51.612 ±2.839 mm) (P<0.01). In mandibule, the mean value for inter-first molar distance was found to be significantly lower among malnourished group(45.475 ± 2.549mm) than well-nourished group(46.249± 2.509 mm) (P<0.05). Concerning inter-second molar distance, the mean value for maxillary inter-second molar distance was found to be highly significant lower among malnourished group(53.695± 2.551mm) than well-nourished group(55.046± 2.516mm) (P<0.01). In mandibule, the mean value for inter-second molar distance was found to be highly significantly lower among malnourished group(48.802± 2.923mm) than well-nourished group(50.002 ± 3.051mm) (P<0.01).

The maxillary and mandibular dental arch length for malnourished group and well-nourished among students aged 15 years are shown in **Table (2).** Concerning anterior arch length, the mean value for maxillary anterior arch length was found to be lower among malnourished group(8.815 ±1.264mm) than well-nourished group (9.128 ± 1.253 mm), with no statistically significant difference (P>0.05). Data demonstrated that the mean value for mandiblar anterior arch length was found to be lower among malnourished group(5.525 ± 0.652 mm) than well-nourished group(5.699 ± 0.678 mm), with no statistically significant difference (P > 0.05). Concerning molar vertical length (MB), the mean value for maxillary molar vertical length was found to be highly significant lower among malnourished group(29.011 ± 1.840mm) than well-nourished group (29.813± 1.901 mm) (P < 0.01). In mandible, the mean value for molar vertical length was reported significant lower among malnourished group(25.406 ± 1.615 mm) than well-nourished group (25.841 ±1.585mm) (P< 0.05). Concerning molar vertical length (ML), the mean value for maxillary molar vertical length was found to be highly significant lower among malnourished group(30.888±1.903mm) than well-nourished group(32.550 ± 1.888mm) (P < 0.01). In mandible, the mean value for molar vertical length was reported highly significant lower among malnourished group(26.669 ±1.469 mm) than well-nourished group(28.064 ± 1.455 mm) (P< 0.01). Concerning total arch length, the mean value for maxillary total arch length was found to be highly significant lower among malnourished group(41.496 ±2.684mm) than well-nourished group(42.473± 2.701mm) (P < 0.01). In mandible, the mean value for total arch length was reported highly significant lower among malnourished group(37.835 ±2.234 mm) than well-nourished group(39.230 ±2.146mm) (P< 0.01).

4. Discussion

This study was conducted to determine 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 (14,15) . Furthermore, the study was conducted among adolescent aged 15 years to represent the permanent dentition stage, as teeth are considered to be fullsize and within the appropriate normal time of complete eruption of all permanent teeth (16-17).Moreover, the 15 age group can represent a proper time for prediction of arch dimension and they are also considered as a static stage. Protein energy malnutrition was assessed in the present study by using the Body Mass Index to classify purely malnourished from wellnourished group. Furthermore, these measuring tools are simple and robust, and can be set up in any environment with noninvasive procedure. WHOrecommended using a -2SD cut off point which represents purely statistical separation of malnourished from wellnourished; therefore, the present study used this particular cut off point. 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.As for the arch width and length measurements of the permanent teeth among wellnourished, 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 arch dimensions; and the varying definitions of well-nourished group, as the previous studies might have included the different degrees of malnutrition.

In general, the out come of the present study showed that the majority linear dental arch measurements which took the width and length of dental arch confirmed the accepted view that the maxillary dental arch is larger in all dimensions than that in the mandibular counterpart among well-nourished group. This is in agreement with the principle that the maxillary dental arch overlaps the mandibular dental arch (18-19).As for the dental arch width in the permanent dentition, the results gathered in the present study reported a larger mean value of both maxillary and mandibular inter-second premolar, inter-first molar and inter-second molar arch widths, in addition to mandibular intercanine and inter first-premolar arch widths in males than in females. These findings are in line with those obtained in other studies (20-22). Protein Energy Malnutrition may be reflected on retardation of the development and growth rate of the hard tissues (23). It affects directly by decreasing bone width as well as delaying the appearance of ossification centers (24-26). The results of present study showed lower mean values of dental arches width, length and perimeterfor maxillary and mandibular dental arches among malnourished group as compared to well-nourished in both genders. This coincides with the finding by Gonçalves*et al* in 2009(27)who found that the trabecular structure of the alveolar bone among well-nourished group was found to be thicker than in malnourished group,however well-nourished group appeared to have predominant Type I collagen fibers.

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Table (1): Maxilllary and mandibular dental arch width (mm) for malnourished and well-nourished groups among students aged15 years.

		Malnourished			Well-nourished			Statistical differences	
		No.	**Mean**	**±SD**	**No.**	**Mean**	**±SD**	**Z -value**	**P-value**
Maxilla	**Inter-canine distance**	83	32.782	2.377	84	33.834	2.337	-3.462**	0.001
	Inter-first premolar distance	83	39.102	2.526	84	40.083	2.435	-2.356*	0.018
	Inter-second premolar distance	83	44.758	3.115	84	46.058	3.073	-2.886**	0.004
	Inter- first molar distance	83	50.127	2.905	84	51.612	2.839	-3.596**	0
	Inter- second molar distance	83	53.695	2.551	84	55.046	2.516	-3.553**	0
Mandible	**Inter-canine distance**	83	24.647	4.017	84	25.504	4.041	-2.482*	0.013
	Inter-first premolar distance	83	32.612	2.266	84	33.042	2.395	-1.325	0.185
	Inter-second premolar distance	83	39.209	2.574	84	40.047	2.526	-2.233*	0.026
	Inter- first molar distance	83	45.475	2.549	84	46.249	2.509	-2.071*	0.038

	Inter- second molar distance	83	48.802	2.923	84	50.002	3.051	-2.796**	0.005

(significant *P<0.05,highly significant**P<0.01

Table (2):Maxilllary and mandibular dental arch length(mm)for malnourished and well-nourished groups among students aged15years

		Malnourished			**Well-nourished**			**Statistical differences**	
		No.	**Mean**	**±SD**	**No.**	**Mean**	**±SD**	**Z -value**	**P-value**
Maxilla	**Anterior arch length**	83	8.815	1.264	84	9.128	1.253	-1.746	0.081
	Molar-vertical distance (MB cusp)	83	29.011	1.84	84	29.813	1.901	-2.767**	0.006
	Molar-vertical distance (ML cusp)	83	30.888	1.903	84	32.55	1.888	-4.876**	0
	Total arch length	83	41.496	2.684	84	42.473	2.701	-3.300**	0.001
Mandible	**Anterior arch length**	83	5.525	0.652	84	5.699	0.678	-1.573	0.116
	Molar-vertical distance (MB cusp)	83	25.406	1.615	84	25.841	1.585	-1.999*	0.046
	Molar-vertical distance (ML cusp)	83	26.669	1.469	84	28.064	1.455	-5.736**	0
	Total arch length	83	37.835	2.234	84	39.23	2.146	-4.622**	0

significant *P<0.05,highly significant**P<0.01