Maximal Mandibular Movements among Tanzanian Children.

***Dr. Mugonzibwa E.A.**

* Department of Orthodontics, Paedodontics and Community Dentistry,
Muhimbili University of Health and Allied Sciences (MUHAS),
Dar es Salaam, Tanzania.

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Address for correspondence:
Dr. E.A. Mugonzibwa,
Department of Orthodontics, Paedodontics & Community Dentistry,
MUHAS, P.O. Box 65104, Dar, Tanzania
Tel: +255 767 606581
Fax: +255 22 2150465
Email: mugonzibwamwanga@gmail.com

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Abstract

Aim: To determine the maximal mandibular movements among Tanzanian children.

Subjects and Methods: Analysis of archived data from 869 subjects aged 3½ -16 years of whom 51% were girls. The emergence status of the permanent teeth was determined and classified into four categories. The study variables were maximal mandibular movement capacity vertically, in laterotrusion and protrusion.

Results: The mean maximum mandibular opening ranged from 43.8 to 55.8 mm between emergence stages of the dentition. The mean values for maximal mandibular movements in laterotrusion and protrusion ranged between 6.3 mm and 7.9 mm at the lowest and highest emergence stage among girls and boys. The mean of the maximum mandibular opening for both sexes increased with the emergence stage of the dentition. **Conclusion:** Sex and emergence stage of the dentition had significant influences on mandibular maximum opening, laterotrusion and protrusion. Similar studies on maximal mandibular movements in different Tanzanian children strata are recommended.

Key words: Maximum Mandibular Opening, Laterotrusion, Protrusion, Tanzania, Children.

1. Introduction

Maximal opening of the mouth is described as the greatest distance between incisal edge of maxillary central incisor to the incisal edge of mandibular central incisor, when the mouth is opened as wide as possible painlessly or as the inter incisal distance plus the overbite (Wood and Branco, 1979). Mouth opening is a clinical parameter, which is encountered routinely in clinicians' and dental students' daily practice. Mandibular movement capacity is an important building block within the clinical evaluation of the functional status of the masticatory system is also used as a marker of masticatory pathology. Increased or limited maximal mandibular movement may be a sign of dysfunction especially in the adult population. Limitation of maximal mandibular opening may be related to many conditions such as temporomandibular disorders, odontogenic infection, oral malignancies, oral submucous fibrosis and trauma while it can cause difficulties in managing patients. Normal mandibular opening capacity values (maximum opening, laterotrusion, and protrusion) used as reference in the Tanzanian clinical situations are based on populations' information from elsewhere (Cortese et al., 2007; Machado et bal., 2009).

A known population mean of mandibular opening capacity is essential to enable clinicians predict possible developing problems with mouth opening capacity. Limited mandibular movements may be one of the first clinical signs of pathological changes and traumatic conditions in the masticatory system. Early recognition of decreased or limited mouth opening capacity is necessary for a prompt diagnosis and efficient treatment planning options.

As shown in table 1, mandibular movement capacity vertically, in laterotrusion and protrusion varies in different children populations while increasing with age until adolescence (Alhuwaizi , 2001; Miller et al., 1999; Hirsch et al., 2006; Sousa et al., 2008; Machado et al., 2009; Müller et al., 2013; Patel et al., 2016). It is then reported that beyond adolescence, mouth opening capacity decreases with age (Miller et al., 1999; Gallagher et al., 2004; Yao et. al., 2009; Khare et al., 2012).

Males have been consistently reported to have larger mandibular movements than females have (Gazit et al., 1984; Ogura et al., 1985; Riolo et al., 1987; Jämsä et al., 1988; Heikinheimo, 1989; Khare et al., 2012). However, there are also reports showing no sex difference in maximal mandibular movement capacity (Bernal and Tsamtsouris, 1985; Rothenberg, 1991; Machado et al., 2009; Kumar et al., 2012) suggesting that at younger ages sexual dimorphism may not be visible yet. Findings reported from other children population samples of different nutritional, socio-economic, cultural and racial background may not necessarily apply to the Tanzanian circumstances.

Generally clinicians working in the head and neck areas including physician, general surgeon and oral health professionals often utilize mouth opening as a clinical diagnostic parameter for head,

neck and oral health disorders in their routine practices. To make such informed diagnoses, knowledge of normal mandibular movement capacity values is very critical. However, baseline data for mandibular movement capacities in Tanzanian children are not available for comparison and generally the Tanzanian population lacks reference population means for various mandibular movement capacity clinical variables. Therefore, an interest to investigate about maximal mandibular movements among Tanzanian children emerged.

2. Subjects and methods

The study involved analyses of the archived data from the study that was carried out in Ilala district, Dar es Salaam, Tanzania. Data was from subjects selected from 16 schools in areas covering the whole range of socio-economic background in urban and peri-urban areas. A detailed description of the sampling procedure can be found elsewhere (Mugonzibwa et al., 2004). The schools were selected from a frame of 500 schools in Ilala District, Dar es Salaam after carefully considering the following factors: the size of the school; the number of Bantu children at the school; interference with ongoing study programmes; and accessibility. The final sample included 869 Bantu children, 428 boys and 441 girls aged 3½-5, 6½-8, 9½-11 and 15-16-year, each age group comprising about 200 children. Distribution of the subjects according to age and gender is given in table 2.

The clinical examination of the children was conducted by the author according to Helkimo's criteria (1974). The emergence status of the permanent teeth was determined by classifying the emergence of permanent teeth into the oral cavity of each tooth into four categories (Pahkala et al., 1991):

0 = the tooth not visible in the oral cavity,

1 = at least one cusp visible in the oral cavity,

2 = the entire occlusal surface/mesio-distal width of the tooth visible,

3 = the tooth in occlusion or at the occlusal level if the antagonistic tooth was not fully erupted.

In addition, extracted permanent teeth were recorded and were converted to emergence category 3 during the data analyses. Secondly, emergence scores of the permanent dentition were calculated as a sum of the emergence categories of individual teeth (minimum=0, maximum=84) and used to determine the emergence stages (ES) of the permanent dentition as follows:

Emergence Stage 0 (ES0)	Complete primary dentition only (ES=0)
Emergence Stage 1 (ES1)	Incomplete first phase of the mixed dentition ($1 \leq ES \leq 35$)
Emergence Stage 2 (ES2)	Complete first phase of the mixed dentition (ES=36)
Emergence Stage 3 (ES3)	Incomplete second phase of the mixed dentition ($37 \leq ES \leq 83$)
Emergence Stage 4 (ES4)	Complete permanent dentition (ES=84).

The distribution of school children according to gender and emergence stage of the permanent dentition is shown in Table 3.

To determine the range of movement of the mandible, the maximum opening of the mandible was recorded in mm. Also recordings for maximal lateral movements of the mandible to the right, left and maximal protrusion were made. For protrusion, the score for maxillary overjet was added.

2.1 Data processing and analysis

Data processing and analysis were carried out using SPSS programme version 19. The intra and inter-examiner agreements for emergence stage of the dentition and dental occlusion variables were assessed by kappa coefficient. The p-values for the effects of emergence stage of the permanent dentition and sex on metric variables of mandibular movements were produced by means of analyses of variance (ANOVA). P-values of less than 0.05 were considered statistically significant.

3. Results

The maximal mandibular movements were accessed from the data of Tanzanian school children aged between 3½ and 16 years. Kappa values (Cohen, 1960) and correlations for emergence stage of the permanent dentition as well as maximum mandibular movements' variables were satisfactory to perfect/excellent ranging from 0.69 to 0.1.00 (Landis and Koch 1977).

Table 4 shows the mean values for the mandibular maximum opening in mm according to gender and emergence stage of the dentition. The mean for the maximum opening of the mandible ranged between 43.8 mm at ES0 to 55.8 mm at ES4. Impaired mandibular movement was rare; only 6 children had a below 40 mm. The gender effect was statistically significant on interaction with the emergence stage of the dentition ($p<0.01$). The mean of the maximum mandibular opening for both boys and girls significantly increased with the emergence stage of the dentition ($p<0.0001$).

The mean values for maximal mandibular movements to the left, right and protrusion ranged between 6.3 mm in girls at ES0 and 7.9 mm in boys at ES4 (Table 5). Gender influence was significant for both mandibular maximal movements to the left side ($p<0.001$) and protrusion ($p<0.002$), respectively. The maximal mandibular movement variables significantly increased with the emergence stage of the dentition ($p<0.0001$).

4. Discussion

In the present cross-sectional community based study, the sample was stratified retrospectively rather

than prospectively. As a result; the subgroups were not evenly distributed with regard to size. The subjects involved in the study were drawn randomly from selected schools of a wide range of social background in Dar es Salaam. Though the sample could not be regarded as representative of the whole Tanzanian child population, the subjects' life style was transitional between the traditional rural and the modern urban way of life. There was no reason to doubt that the findings could not be applied to the then whole Dar es Salaam African child population.

The emergence stage of the permanent dentition was used to classify the children into standardized (identical) dental development groups instead of chronological age (Mugonzibwa et al., 2004). Particularly, Mugonzibwa and colleagues (2004) considered more appropriate to use 'emergence stage' instead of 'eruption stage' and reported Tanzanian children to have permanent teeth emerging into the oral cavity earlier than documented in Caucasian children.

The examiner calibration for the method was done and the reproducibility for presented variables in this study was moderate to almost perfect. According to a six–point scale for interpreting kappa values by Landis and Koch (1977), 0.00 to 0.20 indicates a slight agreements; 0.21 to 0.40 fair agreements; 0.41 to 0.60 moderate agreements; 0.61 to 0.80 substantial agreements; and values above 0.81 indicate almost perfect agreement.

Mandibular movements, especially lateral and protrusive excursions were difficult for some of the youngest children. The same difficulty was also encountered in other studies (Rothernberg, 1991; Pahkala et al., 1991). The mean maximal opening of the mandible was mostly smaller in children with the primary dentition only, but only six children had a mandibular maximum opening of less than 40 mm. However, in children the variation in maximal mandibular opening was wide being probably the reason why mandibular movement capacity in children is rarely considered to be reduced and require no intervention (Pilley et al, 1992; Hirsch et al., 2006). Maximal mandibular lateral movements and protrusion were mostly within the normal ranges in all emergence stages of the permanent dentition and for both boys and girls.

The maximum mandibular opening values in my study were higher compared to those reported from Brazilian, Indian and Swiss children (Sousa et al., 2008; Machado et al., 2009; Kumar, et al., 2012; Müller et al., 2013; Patel et al., 2016). For mandibular movement capacity vertically, laterally (left and right) and anteroposteriorly (protrusion), Tanzanian children had lower values compared to the ones reported among Children in Germany and Iraq (Alhuwaizi , 2001; Hirsch et al., 2006). Differences in the maximal mandibular movements' variables among children and adolescents across studies may be due to the differences in composition of the sample subjects, the study design, differences in definition(s), diagnostic criteria, data presentation as well as different types and/or

qualities of methods of analysis.

With regard to sex, the mandibular movement capacity tended to increase with emergence stage of the permanent dentition in both girls and boys. The findings are comparable to previous reports where the mandibular movement capacity variables increased with age in children and adolescents (Pahkala and Laine, 1990; Pilley et al., 1992; Miller et al., 1999; Hirsch et al., 2006; Cortese et al., 2007; Sousa et al., 2008; Machado et al., 2009; Woolston et al., 2012; Müller et al., 2013; Patel et al., 2016).

Like in some previous studies (Gazit et al., 1984; Ogura et al., 1985; Riolo et al., 1987; Jämsä et al., 1988; Heikinheimo, 1989; Khare et al., 2012), consistently boys had a larger mean of the mandibular movement capacity variables than girls.

In conclusion, both sex and emergence stage of the dentition had significant influences on the maximal movements of the mandible in laterotrusion, protrusion and vertically. Due to trouble causal complexities in the craniomandibular system, other similar studies to assess the scope of the magnitude of variation in the maximal mandibular movements in different Tanzanian children strata are recommended.

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Data processing and analysis **References**

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Table1: Maximum Mandibular Movement Measurements in Various Studies

Sn	Author	Sample size	Grouping	Sample construction	Maximal Mandibular Opening	Right Laterotrusion
1	Alhuwaizi, 2001, Iraq	120		11 – 19 Years	51.13 mm ±6.67	9.27 mm ±1.86
2	Hirsch et al., 2006, Germany	1,011		10–17 Years	50.6 mm ±6.4	10.2 mm ±2.2
3	Sousa et al., 2008, Brazil	303			43.70 mm ±5.81	8.20 mm ±1.97
4	Machado et al., 2009, Brazil	240		6 to 12 Years	44.51mm	7.71mm
5	Kumar et al., 2012, India	856	Boys	Age 6 - 8 Years	46.04 mm	?
				Age 8 - 10 Years	48.53 mm	?
				Age 10 - 12 Years	52.38 mm	?
			Girls	Age 6 - 8 Years	45.95 mm	?
				Age 8 - 10 Years	47.27 mm	?
				Age 10 to 12 Years	52.05 mm	?
6	Müller et al., 2013, Switzerland	20′719	Boys	3 to 18Years	45 mm (25–70)	**?**
			Girls		45 mm (25–69)	**?**
7	Patel et al., 2016, India	985	Boys	5–18 Years	44.24 (±5.84) mm	**?**
			Girls		43.5 (±5.19) mm.	?
8	Current Study Mugonzibwa, 2017, Tanzania	869	Boys	3½ -16 Years	49.8 mm ±6.3	6.9 mm ±1.2
			Girls		49.6 mm ±6.8	6.8 mm ±1.2
			Sample Mean		49.7 mm ±6.6	

? = Not Investigated

Table 2: Distribution of the subjects according age and gender

Age	**Boys**		**Girls**		**Total**	
Years	**n**	**%**	**n**	**%**	**n**	**%**
3½ - 5	126	15	116	13	242	28
6½ - 8	88	10	127	15	215	25
9½ - 11	104	12	105	12	209	24
15 – 16	110	12	93	11	203	23
Total	**428**	**49**	**441**	**51**	**869**	**100**

Table 3: Distribution of the subjects according gender and emergence stages of the dentition (ES0-ES4)[1].

Emergence	Boys		Girls		Total	
stage	n	%	n	%	n	%
ES0	111	13	86	10	197	23
ES1	94	11	113	13	207	24
ES2	24	3	40	5	64	8
ES3	92	11	97	11	189	22
ES4	107	12	105	12	212	24
TOTAL	**428**	**49**	**441**	**51**	**869**	**100**

[1]Emergence Stages (ES):

Emergence Stage 0 (ES0)	Complete primary dentition only (ES=0)
Emergence Stage 1 (ES1)	Incomplete first phase of the mixed dentition (1≤ES≤35)
Emergence Stage 2 (ES2)	Complete first phase of the mixed dentition (ES=36)
Emergence Stage 3 (ES3)	Incomplete second phase of the mixed dentition (37≤ES≤83)
Emergence Stage 4 (ES4)	Complete permanent dentition (ES=84)

Table 4: Mean distribution for mandibular maximum opening in mm according to gender and emergence stage of the dentition (n=844[*])

Emergence	Boys			Girls			Total		
stage[**]									
	n	mean	sd	n	mean	sd	n	mean	sd
ES0	106	44.5	4.2	86	42.9	4.4	192	43.8	4.4
ES1	85	49.3	5.1	104	47.7	4.2	189	48.4	4.7
ES2	24	49.5	4.6	40	50.2	4.5	64	49.9	4.5
ES3	92	50.4	5.3	97	49.9	4.7	189	50.1	5.1
ES4	107	55.0	5.8	103	56.6	6.2	210	55.8	6.02
Total	**414**	**49.8**	**6.3**	**430**	**49.6**	**6.8**	**844**	**49.7**	**6.6**

[*]Some 25 children with missing central incisors could not be measured maximum opening.
**Overall emergence stage influence was statistically significant (p<0.0001)

Table 5: Mean and sd for maximal lateral mandibular movement to the right and left and protrusion in mm according to gender and emergence stage of the dentition

	Right maximum mandibular movement*						Left maximum mandibular movement**					
Emergence	**Boys**			**Girls**			**Boys**			**Girls**		
stage	**n**	**mean**	**sd**	**n**	**mean**	**sd**	**n**	**mean**	**sd**	**n**	**mean**	**sd**
ES0	106	6.9	0.9	86	6.6	0.9	106	6.8	0.9	86	6.6	0.9
ES1	85	6.9	1.1	104	6.8	1.1	85	7.0	1.2	105	6.8	1.2
ES2	24	7.1	1.5	40	6.9	1.3	24	7.4	0.8	40	6.8	1.3
ES3	92	7.0	1.4	97	6.8	1.2	92	7.0	1.3	96	6.8	1.1
ES4	107	6.9	1.2	105	7.1	1.2	107	7.3	1.3	105	7.0	1.2
Total	**414**	**6.9**	**1.2**	**432**	**6.8**	**1.2**	**414**	**7.1**	**1.2**	**432**	**6.9**	**1.2**

*Overall emergence stage of the dentition influence was statistically significant (p=0.03).
**Overall gender and emergence stage of the dentition influence were statistically significant (p<0.001 and p<0001).
***Overall gender and emergence stage of the dentition influence were statistically significant (p=0.002 and p<0001).
+n is reduced due to absence of central incisors and a few incidental missing