Maximum mouth opening

Associated factors and dental significance

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ABSTRACT

الأهداف: قياس الفتحة الفموية القصوى (AMMO) عند عينة من الأردنيين وتحديد ما يؤثر عليها من عوامل وعلاقتها بالوضع السني عند المرضى.

الطريقة: أجريت هذه الدراسة المقطعية على عينة عشوائية تتكون من 496 مريض تتراوح أعمارهم ما بين 80-15عام في مستشفى الجامعة الأردنية – عمان، الأردن خلال الفترة ما بين أكتوبر 2008م و مارس 2009م. تم قياس المسافة القصوى بين القواطع الأمامية العلوية والسفلية.

النتائج: كان معدل الفتحة الفموية AMMO عند العينة (5.7 ± 42.9 مليمتر) وكان الفرق بين الرجال (5.7 ± 45.3 مليمتر) والنساء (5.3 ± 41.5 مليمتر) ذا دلالة إحصائية. قلت كذلك الفتحة الفموية AMMO مع تقدم السن وارتبطت بعلاقة طردية مع وزن وطول المريض ولكنها لم تتأثر بفارق ذو دلالة إحصائية بمؤشر كتلة الجسم، و حالة المفصل الفكي الصدغي. بالنسبة للعلاقة بالوضع السني عند المرضى وجد هنالك علاقة العكسية مع عدد الأسنان المفقودة ولم تكن هنالك علاقة بعدد الأسنان المنخورة أو المحشوة. كانت الفتحة الفموية AMMO عند الأشخاص الذين وجد لديهم أضراس عقل اكبر بفارق ذو دلالة إحصائية من الأشخاص الذين لم تتكون لديهم هذه الأضراس من الأصل، بقيت مطمورة، أو قلعوا هذه الأضراس. كان جنس المريض، و عمره، و وزنه العوامل الوحيدة المؤثرة في تقدير الفتحة الفموية AMMO في التحليل الإحصائي الانحساري.

خاتمة: في هذه العينة، كان مقدار الفتحة الفموية AMMO متأثراً بجنس المريض، وعمره، و وزنه وكان مداها أقل من ما نشر في دراسات مشابهة في أوروبا. تؤدي الفتحة الفموية AMMO الكافية إلى احتمال أقل في فقدان الأسنان، ومحافظة أكثر على أضراس العقل.

Objectives: To estimate active maximum mouth opening (AMMO) in a Jordanian subpopulation and to study associated factors and relationship to patient's dental conditions.

Methods: This cross-sectional study was conducted on 496 patients aged 15-80 years at the University of Jordan Hospital, Amman, Jordan between October 2008 and March 2009. The AMMO was measured **as** maximum distance between incisal edges of upper and lower central incisors. Descriptive statistics and uni- and multivariate analyses were used to determine factors affecting AMMO.

Results: Mean AMMO ± standard deviation was 42.9 ± 5.7 mm. The AMMO varied significantly between men (45.3 ± 5.7 mm) and women (41.5 ± 5.3 mm), decreased with age, and correlated positively with body height and weight, but no relation was found with body mass index and temporomandibular joint complaints. The relationship of AMMO to patient's dental conditions revealed a negative correlation with number of missing teeth, but not with number of decayed or restored teeth. Subjects who had present third molars had wider AMMO compared to subjects with extracted, impacted, or congenitally missing third molars. Multivariate regression analysis revealed gender, age, and weight to be the only independent predictors of AMMO.

Conclusion: In this population, AMMO is influenced by gender, age, and weight of patients and was generally narrower than that reported in European populations. Wide AMMO was associated with less risk of tooth loss and preservation of third molars.

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Examination of mouth opening is a simple and objective test to evaluate temporomandibular joint (TMJ) range of motion (ROM),[1] the latter could be affected by multiple conditions including trauma, neuromuscular disorders, odontogenic infections, advanced oral malignancy, and developmental abnormalities.[2] Active maximum mouth opening (AMMO), defined as the maximum inter-incisal distance,[3] can be used as a screening method to detect conditions that affect TMJ function and masticatory muscle status.[4] When recorded, it serves as a useful parameter in the follow-up of patients under treatment.[2] Reduced TMJ ROM has an impact on the patients' well being and could pose a challenge in intubating patients, thus, it is good practice to record AMMO during assessment of a patient's condition at the time of hospital admission. Few studies have tried to establish populations' norms of AMMO, and most of these were conducted in European countries.[2,5-7] There is a lack of published data on the Jordanian population or other Arab populations for comparison. In addition, information on the relationship between AMMO and the eruption status of third molar teeth is also lacking. Therefore, the aims of this study were to estimate the mean AMMO in a Jordanian population and to investigate the association between AMMO and different parameters including the eruption status of third molars.

Methods. Over a 6-month period from October 2008 to March 2009, this cross-sectional study was conducted at the Department of Dentistry, University of Jordan Hospital (UJH), Amman, Jordan. The study sample of 496 patients was randomly selected from patients who attended this department. The UJH is a teaching hospital in which healthcare services are being provided to students from different parts of Jordan and people living in the capital city of Amman and its nearby villages and refugee camps. The purpose of the study was explained, and subjects who agreed to participate were interviewed and clinically examined. Included patients were those 15 years of age and older with no missing, fractured, or prosthodontically replaced upper or lower anterior teeth. Patients who were found to have a positive history of current infection, jaw or face trauma, tumor, developmental facial anomaly, or systemic disease such as rheumatoid arthritis were excluded. Demographic data such as age, gender, height, weight, and medical history were collected, and body mass index (BMI) was calculated for each subject. The BMI was recorded as: underweight <18.5 kg/m^2; normal weight 18.5-24.9 kg/m^2; over weight 25-29.9 kg/m^2; and obese ≥30 kg/m^2. Each participant was asked regarding any TMJ problems. Patients were asked specifically if they have ever had TMJ clicking or crepitus, or if they have ever attended their dentist's or physician's clinic to treat pain or tenderness related to their TMJs. Patients were then subjected to intraoral examinations to determine the number of missing, decayed, and restored teeth. The DMFT (decayed, missing, and filled teeth) index of all permanent teeth excluding third molars was determined for each subject under artificial light, using a dental explorer, flat-surface mouth mirror, gauze, and compressed air. The clinical presence/or absence of third molar teeth for each patient above 20 years of age was also assessed. As no radiographs were taken, absent third molar teeth were considered congenitally missing, impacted or extracted. The active (voluntary) maximum mouth opening was measured as the distance between the incisal edges of the upper and lower central incisors with the mouth opened maximally using the Willis Bite Gauge. The AMMO to the nearest millimeter was recorded as the mean of 2 measurements made for each subject. A Teaching and Research Assistant who was trained in the measurement of AMMO performed examinations and measurements.

Statistical analysis was performed using the Statistical Package for Social Sciences for Windows release 16.0 (SPSS Inc., Chicago, IL, USA). Descriptive statistics were generated. Means were followed by the value of the standard deviation (mean ± SD). Student's t-test, two-way ANOVA test, and Pearson's Correlations test (r) were used to examine differences between groups. Multiple stepwise linear regression analysis was applied for the determination of the best predictors of AMMO among gender, age, height, weight, BMI, and history of TMJ problems. Coefficients of regression and 95% confidence intervals (CI) were calculated for each significant independent variable. The significance level was stated as $p<0.05$.

Results. A group of 496 patients; 185 men (37.3%) and 311 women (62.7%) were recruited in this study. The ages ranged between 15-80 years, mean was 33 ± 15.2 years. The AMMO for the whole sample varied from 29-71 mm, and the mean was 42.9 ± 5.7 mm. The AMMO in relation to gender and age is shown in **Table 1**. Male AMMO ranged between 33-71 mm, while that of women was 29-60 mm. The highest mean AMMO in men according to age was in those aged 15-19 years and in women was in those 20-29 years of age. Two-way ANOVA test revealed a significant main effect of gender; men had significantly higher mean AMMO than women (45.3 ± 5.7 mm versus 41.5 ± 5.3 mm, $p=0.000$), but insignificant main effect of the different age subgroups ($p=0.11$). The interaction effect of gender and age subgroups was close

Table 1 - Active maximum mouth opening (AMMO) of a Jordanian adult population according to age and gender.

Age (years)	AMMO (mm)								
	Men			Women			Total		
	n	Range	Mean	n	Range	Mean	n	Range	Mean
15-19	21	39-71	47.9	35	29-60	40.6	**56**	**29-71**	**43.3**
20-29	68	33-60	46.0	144	29-55	41.9	**212**	**29-60**	**43.3**
30-39	30	34-57	45.3	36	32-54	41.4	**66**	**32-57**	**43.1**
40-49	28	38-53	44.5	48	32-52	41.4	**76**	**32-53**	**42.5**
50-59	19	36-50	42.1	26	33-50	41.7	**45**	**33-50**	**41.8**
≥ 60	19	37-59	44.2	22	32-48	40.5	**41**	**32-59**	**42.2**
Total	**185**	**33-71**	**45.3**	**311**	**29-60**	**41.5**	496	29-71	42.9

Table 2 - Descriptive statistics of patients' height, weight, and body mass index (BMI) and its relationship to gender.

Parameters	Women				Men				Total				
	Range	Median	Mean	SD	Range	Median	Mean	SD	Range	Median	Mean	SD	*P-value
Height (m)	1.46-1.78	1.64	1.63	0.06	1.50-1.96	1.72	1.73	0.1	**1.50-1.96**	**1.66**	**1.67**	**0.09**	0.000
Weight (kg)	40-115	62.0	64.4	13.1	42-140	75.0	76.7	15.7	**40-140**	**66.0**	**69.0**	**15.3**	0.001
BMI (kg/m^2)	15.9-39.3	23.1	24.2	4.7	15.4-44.1	24.8	25.6	4.6	**15.4-44.1**	**24.0**	**24.7**	**4.7**	0.001

SD - standard deviation, *p-value - by Student's t-test

Table 3 - The status of third molars and its relationship with main active maximum mouth opening (AMMO) for subjects above 20 years of age.

Third molar status	Mean AMMO (mm)	SD	*P-value
Lower right third molar			
Present	44.4	5.9	0.000
Absent	42.2	5.6	
Lower left third molar			
Present	44.2	5.9	0.000
Absent	42.1	4.8	
Upper right third molar	43.8	5.0	0.03
Present	42.5	5.6	
Absent			
Upper left third molar			
Present	43.7	5.5	0.04
Absent	42.5	5.3	

SD - standard deviation. *P-value by Student's t-test, absent means extracted, or congenitally missing, or impacted

Table 4 - Significant independent predictors of active maximum mouth opening in multivariate analysis in women and men.

Gender and independent predictors	B	ß	95% CI of B	*P*-value
Women				
Constant	37.693	-	34.732 - 40.653	0.000
Weight	0.087	0.215	0.033 - 0.141	0.002
Age	-0.056	-0.158	-0.103 - -0.008	0.022
Men				
Constant	47.986	-	45.990 - 49.983	0.000
Age	-0.078	-0.211	-0.131 - -0.025	0.004

B - un-standardized regression coefficient, ß - standardized regression coefficient, CI - confidence interval

to statistical significance (two-way ANOVA, p=0.06). Descriptive statistics of the height, weight, and BMI of the recruited subjects are shown in **Table 2**. Significant differences were found in height, weight, and BMI when men and women were compared. A weak, but significant positive correlation (r=0.21, p=0.000) was found between height and AMMO. Similarly, a weak, but significant positive correlation was found between weight and AMMO (r=0.16, p=0.000). According to the BMI classification system, 4.8% of patients in the sample were underweight, 53.8% were of normal weights, 27.6% were overweight, and 13.7% were obese. No significant correlation was found between BMI and AMMO (r=0.07, p=0.11). When the status of the TMJ was considered, 127 (25.6%) of the patients experienced a TMJ click or crepitus, and 22 (4.4%) attended their dentist or physician's clinic to treat TMJ problems. Patients who had history of TMJ click or crepitus had a mean AMMO of 42.9 ± 5.9 mm, which was similar to those who had no clicking. In contrast, patients who had a history of attendance at their dentist or doctor because of trouble with their TMJs showed a lower mean AMMO (40.6 ± 7.3 mm) compared to those who had no history of attendance (43.0 ± 5.7 mm), and this was close to statistical significance (t-test, p=0.06). In regard to the relationship between AMMO and the patients' dental conditions, a weak but significant negative correlation (r=-0.15, p=0.01) of AMMO was found with the number of missing teeth, but no correlation was found between AMMO and the

number of decayed or restored teeth or DMFT. The status of third molars and its relationship with AMMO for men and women above 20 years of age is shown in **Table 3**. Generally, patients who had present lower (t-test, p=0.000) or upper (t-test, p=0.03 to 0.04) third molar teeth had significantly wider mouth opening compared with those who had these teeth extracted, impacted, or congenitally missing. Multivariate regression analysis revealed gender, age, and weight to be the independent predictors of AMMO in this population. However, considering the highly significant gender related differences, regression analysis was carried out separately for each gender (**Table 4**). When used as continuous variables and the effects of other factors were controlled, age and weight were found to be significant independent predictors of AMMO in women. For every one-year increase in age, AMMO would decrease by an average of 0.056 mm. In contrast, for every one kg increase in weight, AMMO would increase by an average of 0.087 mm. In men, age was the only independent predictor among the factors studied; for every one-year increase in age, AMMO would decrease in men by an average of 0.078 mm.

Discussion. In this study, it was hard to confirm if the recorded mouth opening measurement for each subject was his/her maximum, although we did take the average of 2 measurements. The sample size was also small, and we studied only one area in Jordan due to limitations of time and funds. Therefore, broad generalizations of the findings are not possible, and further study incorporating a nationally representative sample is needed to confirm the results. The AMMO in this study was defined as the inter-incisal distance achieved during maximum mouth opening. Although, adding the overbite to this measurement would be a more accurate reflection of the distance traveled by the mandible,[6] the former measurement alone is the one of clinical and social significance.

In this study, a statistically significant difference was found between AMMO of men and women, and this conforms to previous studies that reported greater AMMO values for men.[1,2,8,9] It was proposed that this was due to gender difference in mandibular length.[1] Mandibular length, measured from the hinge axis to lower incisors, is positively correlated with AMMO since it allows a greater rotation of the hinge joint.[6] However, other studies did not report gender differences in AMMO,[10] and some even demonstrated that women had greater mouth opening if correction were made for stature and body mass.[8] Men also had significantly greater height in this study, and body height had a positive correlation with AMMO. It was noted that there is a trend within populations with decreased average stature to have less range of mandibular motion.[2,11]

The mean AMMO for this Jordanian subpopulation was 42.9 ± 5.7 mm. There is a lack of previous information from this population and other Arab populations for comparison. However, this value is significantly lower than that reported in some European countries, where mean recorded AMMO exceeds 51 mm.[5-7] The AMMO was also significantly higher in African patients, in a Nigerian study, the mean average mouth opening for men was 56.1 ± 4.8 mm and for women 52.3 ± 4.3 mm.[12] Although differences among the samples and measurement methods cannot be excluded, variations in body height between different populations could also explain this difference. These reasons were reported to be the factors explaining the narrower average mouth opening of Japanese subjects compared to Caucasians.[4] Variations in facial morphology between Jordanian and Europeans could be additional factors. It has been reported that 25-40% of inter-individual variations in the range of mouth opening could be explained by inter-individual variations in facial morphology with the angle between the posterior cranial base and mandibular ramus being the most important morphological variable.[6]

This study demonstrated a reduction in AMMO with age in adults, the greatest mean AMMO was seen in the group aged 15-19 years for men, and 20-29 years for women. This is consistent with previous data,[2,11] and it is possible that degenerative joint disease in the TMJ with age affects its ROM. The progression and severity of osseous changes in the condylar head and mandibular fossa increase with age. In older age groups, patients are expected to have more frequent and severe progressive degenerative bony changes due to the development of TMJ osteoarthritis than patients in younger age groups.[13] Although in multivariate analysis, age was an independent predictor of AMMO in both men and women in this study, its effect was more noticeable in men. Although this is difficult to explain, a factor that cannot be ruled out is that young women may find it embarrassing to open their mouth to the maximum.

A correlation was found in this study between weight of the individual and his/her AMMO. Reviewing the literature revealed inconsistent results; while some studies showed a relation between AMMO and body size,[3,9] a lack of such a relation was also reported.[6,8] It is also unknown why this correlation was more evident in females as was shown by the multivariate analysis. In contrast to our findings, Ingervall et al[6] studied the range of mandibular movement in children (7-10 years old) and 20-year old women, and concluded that the opening capacity in children was positively correlated with height and weight, whereas no such correlation was found in young adult women.[6]

Limitation of mouth opening is associated with a number of clinical conditions, one of the commonest

being TMJ dysfunction syndrome (TMD).[2] Symptoms usually include: headaches, jaw pain, and mobility problems such as difficulty with mouth opening. Patients also frequently complain of joint sounds on opening and closing due to mechanical interferences within the joint. A number of studies reported TMJ sounds as the most prevalent sign of TMD.[2,14] In keeping with previous reports,[2,7] in this study there was no significant difference in mean AMMO between those who had experienced TMJ clicking or crepitation, and others. This was attributed to lack of relationship between condylar translation and mouth opening;[15] condylar translation during opening is accompanied by rotational movement. Therefore, the subject could have a limited translation but still have adequate opening because of a greater than normal amount of rotation.[1]

Few studies have looked at the relationship between mouth opening and patients' dental conditions.[16,17] In this study, we conducted full intraoral examinations and found a weak, but significant, negative correlation between AMMO and the number of missing teeth. This could be related to the fact that missing mandibular posterior teeth may accelerate the development of degenerative joint disease and subsequent decrease in mouth opening.[16] Furthermore, Gökçe et al[17] compared mouth opening between dentate and edentulous subjects; they revealed that tooth loss results in a decrease in the angle of mouth opening values.[17] There is a lack of studies examining the relation between mouth opening and third molars status. Subjects with present third molars were found to have significantly greater mouth opening than those with these teeth extracted, impacted, or congenitally missing. As mentioned previously, a correlation was reported between maximum mouth opening and mandibular length and mandibular angle.[4] It is probable that patients with clinically present third molars had a mandibular body length that is long enough to accommodate the mesiodistal dimension of third molars teeth, and this was reflected in their AMMO. Less arch length will lead to a higher chance of impaction of third molars and, if they partially erupt, the risk of pericoronitis and caries will be high and subsequent extraction is expected.

In conclusion, we established basic standard values of AMMO to be used in the evaluation and follow-up of patients with complaints of limited mouth opening. In this population, AMMO was generally narrower than that reported in similar studies conducted in Europe. Of the factors we tested, only age, gender, and weight contributed consistently to the variability in AMMO. An association was found between AMMO and third molar status; however, additional studies on young patients are needed to explore the usefulness of measuring the AMMO in the process of evaluating the eruptive potential of third molar teeth.

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