Maximum mouth opening of ethnic Chinese in Taiwan

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Background/purpose: Maximum mouth opening (MMO) is a significant diagnostic reference for many clinical conditions. However, the number of relevant studies is limited, and the relationship between age and MMO has not yet been established. The purpose of this study was to measure and analyze the MMO of ethnic Chinese adults in Taiwan and to examine the possible relationship between age and MMO.

Materials and methods: A total of 1442 adult ethnic Chinese (Taiwanese) subjects aged 20–80 years (705 males, 737 females) were randomly selected. Subjects were divided into three age groups: 20–39 years (young), 40–59 years (middle), and ≥60 years (senior), and their maximum voluntary mouth opening was measured. Independent sample t test and one-way ANOVA followed by the post hoc Scheffe test were used to examine differences in MMO relative to sex and age groups. A simple linear regression model was used to estimate the relationship between MMO and age.

Results: The average MMO for sample subjects was 49.10±6.30 mm, and the MMO of males (49.92±6.55 mm) was significantly larger than that of females (48.32±5.95 mm; P<0.001). MMO significantly decreased with increasing age, regardless of sex. The average MMO values were 51.11±6.47 mm, 48.45±5.76 mm, and 46.62±5.71 mm for the young, middle and senior age groups, respectively (P<0.001). In the regression model, it was estimated that for every 10 years, MMO decreased by about 1.4 mm in males and 0.9 mm in females. For the age range of 20–80 years, the regression equation is: MMO (mm)=56.60−0.14×age, for males; and MMO (mm)=52.33−0.09×age, for females.

Conclusion: Within the limits of this study, we concluded that both sex and age have significant influences on the MMO value of ethnic Chinese in Taiwan, and age is a significant predictor of MMO measurements.

Introduction

Maximal mouth opening (MMO) is an important diagnostic factor for dental clinicians. Limitation of mouth opening can be related to many conditions such as temporomandibular disorders, odontogenic infection, oral malignancies, oral submucous fibrosis and trauma, and can cause varying degrees of difficulty in managing and treating patients. MMO is a practical diagnostic reference especially for those with temporomandibular joint problems. In addition, measurements of MMO can also provide necessary information for oral instrument design. Despite the clinical significance of MMO, the number of relevant studies is limited, and some would need a substantially larger sample size for valid generalizability.

Research has shown that measurements of MMO can significantly vary with age, sex, and...
stature.\textsuperscript{9–12} Age may be an important predictor of MMO measurements,\textsuperscript{3,4,6} but the relationship between age and MMO has not yet been established. The purpose of this study, therefore, was to measure and analyze the MMO of ethnic Chinese adults in Taiwan and to examine the possible relationship between age and MMO.

**Materials and methods**

In total, 1442 adult ethnic Chinese (Taiwanese) patients aged 20–80 years (705 males, 737 females) from the Dental Department of Shin Kong Wu Ho-Su Memorial Hospital were randomly selected. All of the study subjects were generally healthy and had bilateral natural tooth stops in the anterior and posterior dentition. Patients with a history of temporomandibular disorders, head trauma, head or neck tumors, oral submucous fibrosis or congenital abnormalities in the maxillofacial area, or class III malocclusion (anterior crossbite) were excluded from the study.

Before measuring MMO, subjects were asked to rest in the visiting area for at least 15 minutes. Then, they were put in the supine position in a dental chair. Maximum voluntary mouth opening was accomplished by instructing the subjects to open their mouth as wide as they could. The linear distance between the incisal edge of the same side of the upper and lower central incisors (inter-incisal distance) was measured using a Boley gauge. For each subject, three measurements were successively made within 1 minute, and the highest value of the three measurements was recorded. The overbite was recorded too, but its implications were not analyzed in this study.

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The subjects were divided into three age groups of 20-year intervals for both males and females: 20–39 years (young), 40–59 years (middle), and ≥60 years (senior). Independent sample \( t \) test and one-way analysis of variance (ANOVA) followed by \textit{post hoc} Scheffe’s test were used to examine differences in MMO relative to sex and age groups. A simple linear regression model was used to estimate the relationship between MMO and age.

A two-sided \( P \) value of <0.05 was considered statistically significant.

**Results**

The mean age of the 1442 subjects was 46.2±15.6 years, and females (46.1±15.2 years) were slightly younger than males (46.4±16.0 years). The number of cases in each age group and the sex of those cases are presented in Table 1. The young and middle age groups were composed of 584 (40%) and 525 (36%) subjects, respectively, while the senior group was composed of fewer (333, 24%) subjects.

A comparison between the means of male and female MMO values by age group is illustrated in Fig. 1, and the mean values of MMO by age group are presented in Table 2. The average MMO for

<table>
<thead>
<tr>
<th>Age group</th>
<th>Young (20–39 years)</th>
<th>Middle (40–59 years)</th>
<th>Senior (≥60 years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male (( n = 705 ))</td>
<td>288</td>
<td>240</td>
<td>177</td>
</tr>
<tr>
<td>Female (( n = 737 ))</td>
<td>296</td>
<td>285</td>
<td>156</td>
</tr>
<tr>
<td>Total (( n = 1442 ))</td>
<td>584</td>
<td>525</td>
<td>333</td>
</tr>
</tbody>
</table>

\[fig:1\] Comparison between mean male and female maximum mouth opening (MMO) values by age group. *\( P < 0.001 \) by independent sample \( t \) test; †\( P < 0.01 \) by independent sample \( t \) test.

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A comparison between the means of male and female MMO values by age group is illustrated in Fig. 1, and the mean values of MMO by age group are presented in Table 2. The average MMO for
all 1442 subjects was 49.10 $\pm$ 6.30 mm. There was a significant difference in MMO between males and females for both the young ($P < 0.001$) and middle age groups ($P = 0.007$), but not for the senior group ($P = 0.352$) (Fig. 1). However, the average MMO of males (49.92 $\pm$ 6.55 mm) was significantly larger than that of females (48.32 $\pm$ 5.95 mm; $P < 0.001$).

There were significant decreases in MMO with increasing age, regardless of sex (Table 2). Average MMO values were 51.11 $\pm$ 6.47 mm, 48.45 $\pm$ 5.76 mm and 46.62 $\pm$ 5.71 mm for the young, middle and senior age groups, respectively ($P < 0.001$).

The tendency of MMO to decrease with age was obvious, as shown in Figs. 2 and 3 which depict scatter and linear regression diagrams in which the slopes on both graphs were negative ($P < 0.001$). In the regression model, it was estimated that for every 10 years, the MMO decreased by about 1.4 mm for males and 0.9 mm for females. The degree of the reduction was slightly less for females than males.

Regression equations were deduced by calculating the regression coefficient and intercept. For the age range of 20–80 years, the regression equation was: MMO (mm) = 56.60 $-$ 0.14 $\times$ age, for males; and MMO (mm) = 52.33 $-$ 0.09 $\times$ age, for females.

Discussion

MMO varies among individuals. Research has found that MMO is influenced by a number of factors including age, sex, and anthropometric measures such as stature,9–12 the size of the mandible13–15 and the cranial base.13 We found that both age and sex had significant influences on the MMO of ethnic Chinese in Taiwan.

When measuring MMO, head position is an important factor.16–18 Higbie et al.16 described how MMO decreases in the order of forward, natural and retracted head positions. Here, all subjects were
placed in a supine position for measuring in order to eliminate the possible influence of different head positions.

MMO has been described either as the inter-incisal distance\(^3,6,10,19\) or as the inter-incisal distance plus the overbite.\(^4\) Measurement of the inter-incisal distance plus overbite means measurement of the vertical distance traveled by the mandible. However, as pointed out by Mezitis et al.,\(^3\) the functional opening of the mouth is more important, because this is the value that actually affects chewing and dental treatment. Hence, the inter-incisal distance was used as the MMO measurement in this study.

The inter-incisal distance during active opening was used as the MMO measurement in most studies.\(^6,11,19\) An advantage of the incisal edge distance measurement is that the measuring point is relatively more permanent and more easily determined. An extraoral measurement was also used in some studies. Wood and Branco\(^20\) compared direct and extraoral measurements, and concluded that direct measurements using a ruler were more precise and accurate.

Among the three measurements taken for each subject, the first measurement of MMO was generally greatest in this study. This might have been caused by decreasing muscle power with succeeding measurements. However, some authors do not agree with that.\(^3,9,19,21\) Passive mouth opening by an investigator was also employed in some studies, and the value of MMO was found to be greater than that of active MMO.\(^14,15,22\) This may have been because of the application of external force during measurement.

The correlation between MMO and stature is controversial. Some studies described a positive relationship,\(^9–12,14\) while others did not.\(^4,13\) Westling and Helkimo\(^14\) mentioned that MMO is relatively dependent on the size of the mandible, which is obviously greater in males. Since human males are generally taller and larger than females, it is conceivable that MMO would be larger in males. In addition, Dijkstra et al.\(^15\) pointed out that differences in MMO may be attributed to the mandibular length. The majority of MMO studies, including the present study, demonstrated a sex difference between males and females.\(^3–5,8\) Whether or not the difference is attributable to a variation in stature remains unclear. Further investigation is required to clarify possible correlations among these factors.

Studies have shown that MMO steadily increases after birth until adulthood,\(^6,9,12\) and then gradually decreases as aging progresses.\(^3–7\) We also found a trend for reduction of MMO with age for adult ethnic Chinese people. This decrease was about 1.4 mm in males and 0.9 mm in females for every 10 years after entering adulthood. The cross-sectional study design of our investigation, however, might not be able to demonstrate the actual MMO decrease in an individual. Longitudinal studies are required to confirm this tendency.

In addition to the factors mentioned above, racial differences are another issue of concern. Studies of MMO from different countries are described in Table 3. There is a wide range of average MMO values in different studies. Although MMO values of Asians seem to be smaller than those of Caucasians, we could find no obvious racial differences when comparing the present study results with others.

There are two limitations of this study. First, study subjects were selected from one medical center in Taipei City. Almost one-third of our dental patients come from satellite cities and nearby towns, and many of the inhabitants there are immigrants from central and southern Taiwan. To a certain extent, therefore, the sampled subjects may be representative of the island’s population. Second, we deliberately classified subjects’ ages into three categories to simplify the analyses, which might have influenced the results. However, this should not be a major caveat to our results considering the relatively large sample size.

In summary, within the limits of this study, we concluded that both sex and age have significant influences on the MMO value of ethnic Chinese in Taiwan, and age is a significant predictor of MMO.
measurements. Further research should be carried out to determine the underlying factors that contribute to such variations.

References