Dentistry 3000
Vol 13 No 2 (2024) DOI 10.5195/d3000.2024.704

Maximum mouth opening measurement in relation to maximum bite force among children

Dalya Rafie Mohammed, Aseel Haidar M J Al Haidar

College of Dentistry, University of Baghdad, Iraq

Abstract

Objective: This research aimed to study the relation between maximal bite force (MBF) and maximum mouth opening among 12-year-old school children.

Methods: In this cross-sectional study, a total of 400 children aged 12 years (194 boys and 206 girls) were examined. The MBF for the right and left side, as well as the anterior region, were evaluated for all children. The MMO was measured using an electronic digital caliper. To analyze the data path analysis method was used.

Results: Boys showed a higher MMO of 48.797 ± 6.500 than girls (46.710 ± 5.926 mm). The MMO increased with increasing MBF, with significant differences between females and males.

Conclusion: The MMO was higher in boys than in girls. Gender plays a significant role in MBF strength.

Keywords: Bite force; children; digital caliper; human; mouth opening; sensor.

Citation: Mohammed DR, et al. (2024) Maximum mouth opening measurement in relation to maximum bite force among children. Dentistry 3000. 2:a001 doi:10.5195/d3000.2024.704
Received: August 14, 2024
Accepted: August 24, 2024
Published: September 25, 2024

Email: Dr.dalya_1993@yahoo.com

Introduction

Bite force (BF) refers to "the force exerted by the masticatory muscles during teeth contact, and it is a key factor in assessing the performance and efficiency of the masticatory system". Various factors, including age, gender, craniofacial morphology, body size, masseter muscle thickness, number of erupted teeth, and dental occlusion, influence human bite force (1,2). It is closely associated with the health of the masticatory system (3). Tooth eruption indicates overall body growth. Also delayed tooth eruption can limit overall body growth (4). Teeth play an essential part in the masticatory apparatus as they form the occlusal area responsible for the breakdown of food particles. Thus, the total occlusal surface and the number of teeth will determine the grinding force (5). Maximum mouth opening can be defined as "the greatest distance, when the mouth is open as widely as possible, between the incisal edges of the mandibular and maxillary central incisors at the midline" (6). Both dental disease and the therapy itself can really have a detrimental effect on the quality of life related to oral health (7). Various diseases and conditions, including trauma, inflammation, temporomandibular joint problems, neurological disorders, hyperplasia of the coronoid process, rheumatoid arthritis, adverse effects of medicines, tumors, and results of head and neck cancer radiotherapy, can restrict mouth opening (5). In addition, the inability to open the mouth can sometimes lead to legal issues, and pediatric dentists who work with a child's oral cavity encounter

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different levels of difficulties when there are limitations in mouth opening (8). The present study aimed to examine the possible relationship between the MMO with gender and MBF.

Material and Methods

Design and sample

The study was approved by the Scientific and the Ethical Committee of Baghdad University, College of Dentistry (731322) and was carried out in agreement with the principles of the Declaration of Helsinki.

All the selected students were in healthy mental and physical conditions. All were examined by the author to reduce bias during the collection of data. A clinical assessment was performed following the receipt of a signed informed consent from the appropriate school authorities and the parents of each child involved in the study.

The inclusion criteria for the students in this study were as follows: absence of any preceding orthodontic treatment and/or orthognathic surgery, absence of an anterior or posterior crossbite or an open bite, no history of any systemic disease, no dysfunction of the temporomandibular joint and no congenital disability (cleft lip and palate) or deformed teeth. Children with incompletely filled consent forms, facial abnormalities or open bites, fractured central incisors, or any prosthetic device were not included in the study. A total of 400 students (206 girls and 194 boys) who were 12 years old, from various public schools in Baghdad were included in this study, which was conducted from December 2022 until May 2023. The participants were separated into two groups, one consisting of 206 girls and the other of 194 boys.

Ethical considerations

The study proposal was submitted to the Ethical and Scientific Committee at the Department of Pediatrics and Preventive Dentistry at the College of Dentistry at Baghdad University in Iraq, and a formal registration number was obtained (Project no. 731322). The study's objective was clarified to the parents, and explicit agreement was acquired from the parents of the children participating in the study.

MBF Measurement

Bite forces were assessed via a portable biting force sensor manufactured by Loadstar Sensor Company, based in the United States. The device had a maximum capacity of 100 kg, it had a diameter of 13 mm and a total vertical height of 7 mm. A computer was utilized to receive, process, and display the information using a specialized software program (9).

Each student sat upright, with the head in a natural posture without head support and the students were instructed to bite the sensor (that was covered with sterile disposable latex) as hard as they could. BF measurements were taken between the central incisors and the first permanent molars (both right and left). This method was performed three times per student on each side, with a 10-second rest period between each bite. The student's MBF was determined by taking the highest of the three bite force readings (9). The latex finger cots were changed after each recording, and 70% isopropyl alcohol was used to clean the device.

MMO Measurement

MMO was evaluated by instructing the students to open their mouth to the maximum possible extent. The examiner recorded the maximum distance at the midline between the incisal edges of the mandibular and maxillary central incisors. In order to measure the MMO, an electronic digital caliper was utilized while the students

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were in an upright posture, with their heads resting on a solid wall surface (6).

Statistical analysis

SPSS (version 22, Chicago, Illinois) was used to examine data. A significant criterion of $p < 0.05$ was established. Frequency of MBF, including the means and standard deviations were calculated. The findings were analyzed using independent t and chi-square tests. Regression analysis was used for determining the best predictors of MMO.

Results

Table 1 illustrates the distribution of study sample based on gender regarding MMO. A statistical significant difference was found, where the boys had higher mean of MMO than that of girls (48.797 ± 6.500, 46.710 ± 5.926 mm, respectively). According to the results presented in Table 2, a significant linear relationship, but a weak positive correlation, was found between the maximal mouth opening and MBF for the left, right, and anterior areas and the total MBF.

Table 1. Distribution of study sample based on gender regarding MMO.

Variable	Maximum mouth opening	
Gender	Boys	Girls
Number %	194 (48.5 %)	206 (51.5 %)
Minimum	31.05	29.39
Maximum	62.08	59.40
Mean± SD	48.797 ± 6.500	46.710 ± 5.926
T-test	3.358	
P value	0.001*	

Table 2. Pearson's correlation coefficient between maximal mouth opening and maximum bite force.

Max. mouth opening	Gender	MBFR		MBFL		MBFA		MBF	
		R	P	R	P	R	P	R	P
	Boys	0.197	0.006*	0.136	0.058	0.090	0.213	0.176	0.014*
	Girls	0.151	0.030*	0.102	0.144	0.067	0.338	0.130	0.063
	Total	0.202	0.000*	0.144	0.004*	0.102	0.042*	0.181	0.000*

*: Significant.

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Discussion

The MMO measurement has clinical and social implications. The inter-incisal distance plus overbite measurement represents the vertical distance travelled by the mandible (6). Nevertheless, Mezitis et al. (10) emphasized that the functional act of opening the mouth holds more importance since it directly affects both chewing and dental procedures. Measurements of the individual bite force have been conducted to assess the therapeutic effectiveness of the prosthetic device and understand the mechanics of chewing. This information is essential for the process of treatment planning, especially when creating the prosthesis (11).

The novelty of the present study was to investigate maximal mouth opening in healthy children and MBF in 12-year-old Iraqi school children. The current cross-sectional study can potentially establish a reference value for biting force that can be used in future investigations. Hence, the bite force sensor is suitable for pediatric use according to the present study. The device is user-friendly, noninvasive, and portable.

The device has a digital screen and compact load cells that are sufficient for measuring bite force in clinical settings. In addition, it provides standard values and details on the variables that affect their variability. The results revealed a statistically significant difference between MMO and gender, like the results of other studies (5,12). In the present study, the maximal mouth opening was observed to be larger in boys than in girls, which is in line with the previous studies that reported higher MMO among male subjects (6,13,14). However, the present results disagreed with some studies that did not show the effect of gender in MMO (15–18). On the contrary, some studies showed that girls had higher MMO than boys (13,19,20). This study utilized a specialized bite force sensor to get accurate and comfortable measure to the maximal force exerted while biting.

The Pearson correlation value indicated a slight positive association between MBF and MMO in permanent teeth. This finding coincides with the results reported by Su et al. (21). This study's findings differ from previous research conducted in 2003 by the team of Su et al., which focused on children aged nine to twelve. The jawbone and masticatory muscles of young preschoolers still in the process of developing. In contrast, regression analysis revealed a positive connection between BF and maximal mouth opening on both the left and right sides. These findings indicated that the bite force increases as the size of the mouth aperture increases. Fields et al. did a study that discovered a similar association among adults (22). According to the findings of the current inquiry, there is a direct relation between MBF and MMO.

The study potential limitations may include the study's restricted period. The study utilized a cross-sectional design rather than a longitudinal design.

Additional research is required to be conducted using a larger sample size while also comparing various BF instruments and assessing biting force across different people, as well as other anthropological characteristics and variables.

Conclusion

The study's results indicated that there was a substantial variation in maximum mouth opening across genders among children with permanent dentition, where maximal mouth opening was higher in boys than in girls. The MMO showed favorable associations with MBF. A weak but

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positive correlation has existed between maximal biting force and MMO.

Acknowledgements

We appreciate all personnel at College of Dentistry, University of Baghdad, Iraq for their support and assistance during the study.

Authors' Contribution

Conceptualization, investigation, methodology and writing original draft: Dalya Rafie.

Supervision: Aseel Haidar.

Review & Editing: Aseel Haidar.

Source of funding

None.

Conflicts of interest

The authors claim no conflicts of interest.

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