

Maximum Bite Force in Children with Primary Dentition: Influence of Gender and Anatomical Region – A Pilot Study

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Abstract

Mastication is a fundamental function that develops during early childhood and plays an important role in craniofacial growth. Maximum bite force (MBF) is a key indicator of the functional capacity of the masticatory system and is influenced by various biological and functional factors. The aim of the present study was to evaluate maximum bite force in children with primary dentition using a gnathodynamometer and to analyze its variation according to gender and anatomical region. The study included 26 children with fully developed primary dentition (16 boys and 10 girls). Measurements were performed in the frontal region and in the right and left molar regions, with each measurement repeated three times. The results showed that, in both boys and girls, lower mean MBF values were recorded in the anterior (frontal) region compared to the posterior regions. Among the posterior areas, the highest values were observed in the right molar region in boys, whereas the lowest values were found in the left molar region in girls. Statistically significant differences between boys and girls were found in all examined regions. Overall, MBF values were higher in boys and in posterior regions, and greater on the right side compared to the left. These findings indicate that maximum bite force in children with primary dentition is influenced by gender and anatomical region and should be considered in the assessment of masticatory function.

Keywords: maximum bite force, gnathodynamometer, primary dentition

Introduction

Mastication is a function that begins its development in early childhood and is refined through the accumulation of experience. When functioning normally, it provides the necessary stimuli for the proper development of the maxilla and mandible (1, 2). Masticatory efficiency is defined as the

ability of an individual to break down food into particles of appropriate size for swallowing. It is associated with the coordination of masticatory movements, muscle activity, and occlusion. Masticatory efficiency represents a functional outcome of the chewing process and does not depend solely on bite force (1). Masticatory efficiency is influenced by several factors, including the presence of malocclusion, occlusal contact area, body size, the number of functional tooth units, and bite force. The contact surfaces between occluding teeth determine the area available for food shearing during masticatory cycles (1).

Bite force is one of the components of masticatory function. It increases progressively during childhood, remains relatively constant between 20 and 40 years of age, and then gradually declines (3). Maximum bite force represents the greatest force that an individual can generate during voluntary jaw closure without causing pain in the periodontal tissues, typically measured in newtons (N) at a specific point. It is a quantitative indicator of the functional capacity of the masticatory system (4, 5). The values of maximum bite force are determined by multiple factors, among which craniofacial morphology, general muscular strength, and gender differences play a leading role (6). Additional factors include the condition of the dentition, the characteristics of the measuring device used, as well as the presence of malocclusions and temporomandibular disorders (7). The individual characteristics of the masticatory muscles, including their size, composition, and mechanical advantage, also play a significant role. A significant difference in bite force between sexes has been reported, with females generally exhibiting lower values of maximum bite force (8). Malocclusions, carious destruction of teeth, pain, and infections have been shown to reduce maximum bite force (7).

Primary dentition has a direct influence on the development of permanent dentition; therefore, conditions that may interfere with growth and development should be carefully considered.

Aim

The aim of the present study is to evaluate maximum bite force in children with primary dentition using a gnathodynamometer and to analyze its variation according to gender and anatomical region.

Materials and Methods

A pilot study was conducted including 26 children with primary dentition – 16 boys and 10 girls. The inclusion criterion was the presence of a fully developed primary dentition without signs of physiological transition to permanent teeth. Exclusion criteria included partially erupted or non-occluding incisors and second primary molars, as well as mobile or cariously destroyed incisors and second primary molars, and the presence of severe orthodontic anomalies.

For the purposes of the study, a force-measuring device—a gnathodynamometer (Fig. 1)—was used. The device consisted of a programmable indicator (GD500.2) with an accuracy class of 0.1, a tensometric force-measuring module with a capacity of 500 N and a measurement range of 0 to 500 (650) N, and an electric power supply.

Prior to the examination, each child was instructed about the procedure. The participants were asked to clench their teeth initially until contact with the tensometric measuring module was achieved, and then to continue biting up to the threshold of discomfort, i.e., to the maximum force they could exert without experiencing unpleasant sensations in the periodontal tissues.



Measurements were performed in each participant in three regions: first in the frontal region (central incisors), followed by the right and left molar regions (second primary molars). In each of the three regions, measurements were performed three times for every participant, with a 30-second rest interval between repetitions to allow for muscle recovery.

All data were recorded in a specially designed table and statistically analyzed using IBM SPSS Statistics 23.0. The level of statistical significance was set at $p < 0.05$

Fig.1 Gnathodynamometer - force-measuring device

Results

The results of the statistical analysis of the data obtained from the measurement of maximum bite force in primary dentition using a gnathodynamometer are presented in Table 1.

Table 1. Maximal bite force in primary dentition

	Girls Frontal	Girls Right	Girls Left	Boys Frontal	Boys Right	Boys Left
Mean	35.6	95.1	78.1	63.81	166.44	181.63
Std. Deviation	21.27	45.01	32.25	21.44	62.7	41.11
Minimum	14	43	36	23	52	107
Maximum	77	155	135	87	281	236

The table presents the mean values of maximum bite force in boys and girls across each of the examined regions of the dentition.

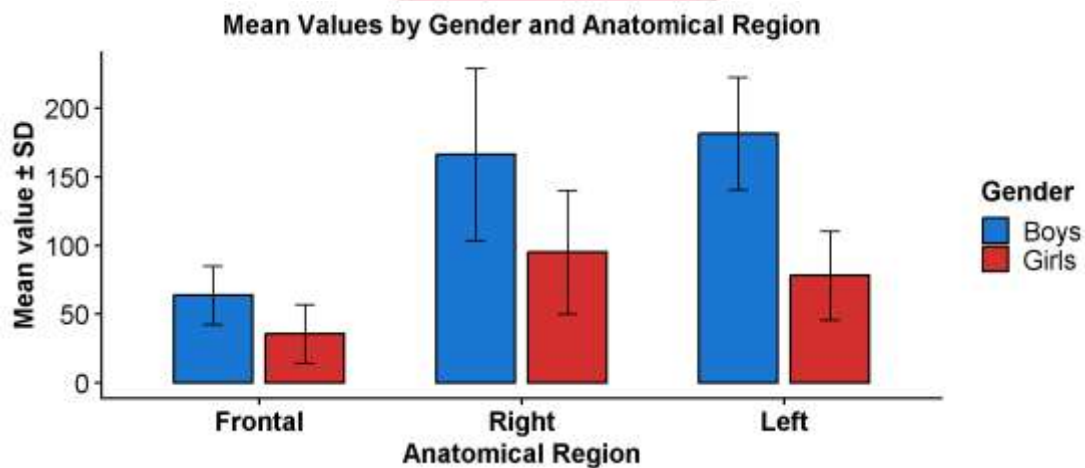


Fig.2 Mean Values by Gender and Anatomical Region

The mean values of maximum bite force (MBF) were compared between boys and girls across the three examined regions. In the frontal region, a statistically significant difference was found between the two groups, indicating a substantial gender-related difference. Similarly, statistically significant differences were observed in the posterior regions. In the right molar region, the difference between groups was significant ($p = 0.005$), while in the left molar region a highly significant difference was found ($p < 0.001$). Overall, the results demonstrate significant gender-related differences in maximum bite force across both anterior and posterior regions in children with primary dentition.

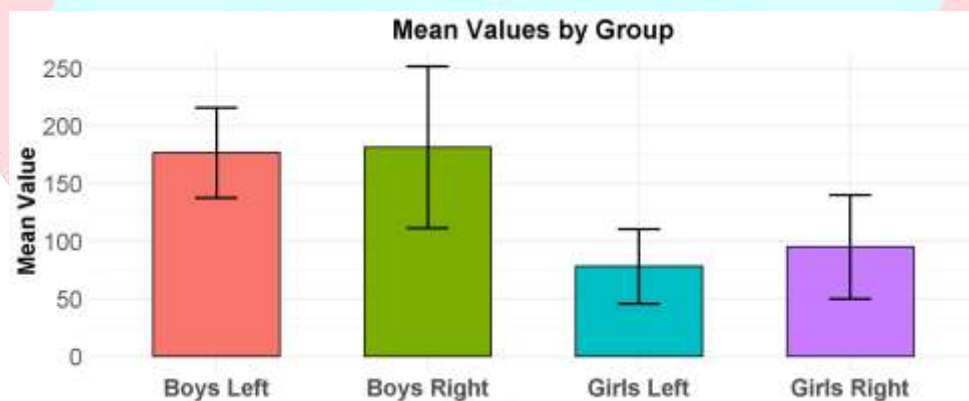


Fig. 3 Mean Values by group

The results show that the highest mean values of maximum bite force (MBF) were recorded in the region of the right second primary molars in boys, whereas the lowest values were observed in the region of the left second primary molars in girls. In both sexes, MBF values were higher on the right side compared to the left.

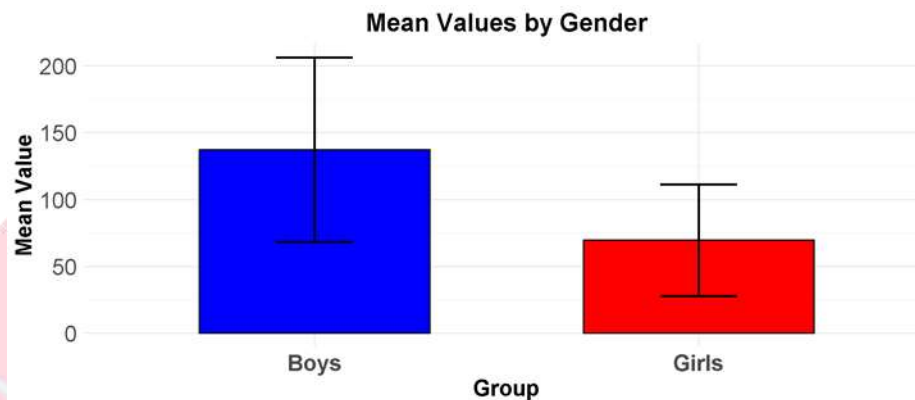


Fig. 4 Mean Values by Gender

A two-tailed t-test for independent samples showed that the difference between Girls total and Boys total was also statistically significant, $p < 0.001$, 95% confidence interval.

Discussion

The results of the present study are consistent with those reported by Gavião et al., who found considerable variability in maximum bite force values in children with primary dentition. The authors did not identify a direct relationship between MBF and masticatory efficiency, suggesting that bite force alone is not a reliable indicator of functional chewing efficiency in early childhood (1). This may be explained by the fact that masticatory efficiency depends not only on force magnitude but also on neuromuscular coordination, chewing patterns, and the number of functional tooth units, which are still developing in early childhood (1). In addition, chewing efficiency is influenced by factors such as jaw movement patterns and food manipulation, which are not directly related to maximum force generation and may further explain the lack of direct correlation between MBF and functional performance (1).

One of the possible explanations for the observed variability in MBF values is the immature neuromuscular control in children. At this stage, the central nervous system and peripheral sensory feedback mechanisms, including periodontal mechanoreceptors, are not fully developed, which may lead to inconsistent muscle recruitment and reduced ability to generate maximal force (9). Additionally, children's cooperation, motivation, and understanding of the task may influence bite force measurements, further contributing to variability (9). It has also been suggested that children demonstrate a protective neuromuscular response that limits force generation in order to avoid discomfort or damage to developing oral structures, which may further reduce recorded MBF values (9). Other studies, similarly to the present one, have demonstrated a relationship between MBF and gender, with higher values observed in boys (10,11). The authors reported MBF values in the range of 176–240 N, which increase with age (10). This gender-related difference may be attributed to greater muscle mass, increased cross-sectional area of the masticatory muscles, and differences in craniofacial morphology observed in boys (10).

The study by Mutt et al. reported lower MBF values in primary dentition, which may be explained by differences in the measurement methodology, particularly the use of a digital sensor. At the same

time, they confirmed the relationship between MBF and various anthropometric factors, such as age, height, and weight, which show a directly proportional influence (12). These findings are supported by evidence that bite force is positively associated with somatic growth and muscle development, as increases in body size are accompanied by enhanced muscle strength and improved force generation capacity (12). Moreover, increases in occlusal contact area with growth further enhance force transmission efficiency, contributing to the progressive rise in MBF values with age (13). Some authors also reported higher MBF values in boys compared to girls, although this difference did not reach statistical significance in primary dentition (12). Maximum bite force of primary dentition was significantly correlated with occlusal contact area, height and weight of children. Occlusal contact points with maximum bite pressure and occlusal bite balance points of primary dentitions are mostly located in primary molar regions (13).

Similar bite force ranges (approximately 100–200 N) in children with primary dentition have been reported by Aljaiha et al., supporting the variability observed in the present study (14). This variability may also be influenced by occlusal instability during primary dentition, as incomplete intercuspation and reduced occlusal contact areas can affect the efficiency of force transmission (15). In addition, physiological root resorption of primary teeth and changes in periodontal ligament properties may temporarily reduce tooth stability and affect force distribution (15).

Higher bite force values in the molar regions compared to the frontal area observed in this study are consistent with previous findings (Sonnesen & Bakke) and can be explained by the larger occlusal contact area and the biomechanical advantage in the posterior region (16). From a biomechanical perspective, posterior teeth are located closer to the temporomandibular joint and function under a more favorable lever system, allowing greater force generation with reduced mechanical disadvantage (17). In addition, the larger periodontal support and root surface area of molars contribute to improved force distribution and stability during clenching (16).

Furthermore, MBF should be considered a multifactorial parameter influenced not only by anatomical and biomechanical factors but also by neuromuscular adaptation. During childhood, ongoing development of muscle activity patterns and occlusal relationships continues to shape the functional capacity of the masticatory system (18).

Limitations of the study

The present pilot study has several limitations, including a relatively small sample size and the lack of consideration of variables such as body weight, age variation, height, muscle mass, and chewing side dominance. Additionally, the “discomfort threshold” criterion is inherently subjective, particularly in children.

Conclusion

The present study demonstrated that maximum bite force in children with primary dentition varies significantly according to gender and anatomical region. Higher values were observed in boys compared to girls, as well as in the posterior regions compared to the frontal area. Additionally, bite force was greater on the right side than on the left in both sexes.

These findings confirm that maximum bite force is influenced by biological and functional factors, including gender and occlusal conditions. The results contribute to a better understanding of masticatory function in early childhood and may be useful for clinical assessment and monitoring of functional development in pediatric patients.

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