

# Maximum bite force and related dental status in children with deciduous dentition

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*Six hundred seventy-six Taiwanese children with deciduous dentition were sampled for maximum bite force and related dental status. Sixty-seven percent of children had at least one decayed tooth. The mean number of decayed teeth of all children was  $2.97 \pm 3.58$ , and the mean plaque index of the right maxillary central incisor was  $2.00 \pm 0.75$ . Twenty-seven percent of children had occlusal anomalies. Boys had a statistically significantly larger maximum bite force than did girls. Children with normal occlusion had statistically significantly larger maximum bite forces than did children with malocclusion. A statistically positive correlation was found between the number of decayed teeth and the plaque index. However, a statistically negative correlation was found between the number of decayed teeth and the maximum bite force and between the plaque index and the maximum bite force.*

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## INTRODUCTION

Various techniques have been used to clinically evaluate the physiological characteristics of the muscles of mastication. One method is to measure the bite force. Bite force is exerted by the jaw elevator muscles and is regulated by the nervous, muscular, skeletal, and dental systems.<sup>1</sup> Maximum bite force is related to the health of the masticatory system, and it is believed that the stronger the bite force, the better the system.<sup>2,3</sup> Helkimo *et al.*<sup>4</sup> observed the bite force of a population between the ages of 15 and 65 years, and found that variation in bite force with dental status was obvious, and that those with complete dentition had a much greater bite force.

Maximum bite force assessed unilaterally may be used as a simple indicator of mandibular elevator muscle strength as a whole.<sup>5</sup> Since reduced strength is an important factor in overload and hyperactivity of masticatory muscles and a common feature of patients with craniomandibular disorders,<sup>6,7</sup> assessment of bite force is relevant for diagnosis and treatment planning. Routine recordings of bite force for clinical purposes

can provide normal values and knowledge of factors responsible for their variability.<sup>8</sup>

Relatively few studies have been conducted regarding the bite force of young children. The purpose of this study was to investigate the relationship between maximum bite force and dental status for deciduous dentition.

## MATERIALS AND METHODS

The subjects in this study consisted of 676 Taiwanese children (374 boys and 302 girls) aged 3-5 years, who were all in Hellman's dental age IIA. The children were from six randomly selected kindergartens in Taichung City, an area where tap water is not fluoridated. After informed consent was obtained, clinical examinations were conducted by the author in natural daylight conditions, with the children seated on a chair. The examination included determination of the number of decayed teeth (dt), the plaque index (PII)<sup>9</sup> at the central third of the labial surface of the right maxillary central primary incisor with the aid of a dental probe (a tooth was excluded if it was being shed or was missing), and occlusal anomalies (malocclusion) assessed in centric occlusion as follows:

1. Anterior crossbite was recorded when one or more of the maxillary incisors occluded lingually to the mandibular incisors.
3. Anterior open bite was recorded when there was no vertical overlap of the incisors.
4. Posterior crossbite was recorded when one or more of the maxillary primary canines or molars occluded palatally to the buccal cusp of the opposing mandibular teeth.

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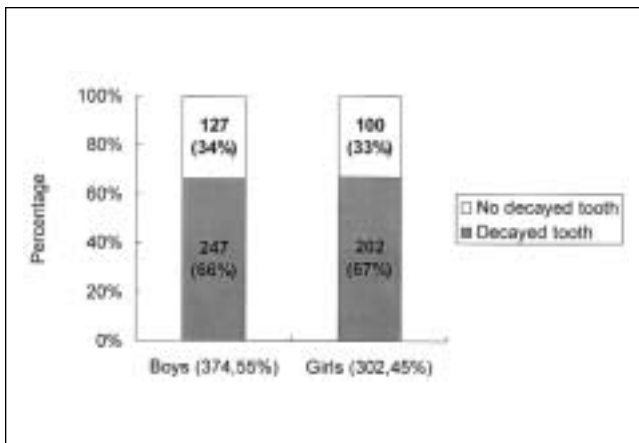


Figure 1.

5. Crowding in the anterior segment was recorded when the estimated space within the dental arch was not sufficient for the incisors to be aligned properly.
6. Maxillary protrusion was recorded when overjet was more than 2 mm and overbite was 0-2 mm.
7. Deep bite was recorded when overjet was 0-2 mm and overbite was more than 2 mm.

After the clinical examination, maximum bite forces were measured using a custom bite force gauge (Occlusal Force-Meter GM10, Morita Corp., Japan). All measurements were made with the children seated, and their head upright, looking forward, and in an unsupported natural position. For each child, the gauge was placed between the deciduous second molars on each side, and was maintained approximately parallel to the floor in frontal view. Each child was instructed to bite as hard as possible and maintain the force for a 1-s period three times in succession, resting 2 to 5 s between each bite. The largest value was selected as the maximum bite force. Children were excluded from this study if they were missing teeth in this region.

The mean and standard deviation were calculated for the number of decayed teeth, plaque index, and the maximum bite forces measured. Differences between the mean values were tested between sexes and between normal occlusion and malocclusion by means of Student's *t*-test. Pearson's product moment correlation test among number of decayed teeth, plaque index, and maximum bite force was then performed. Significant differences for all correlation coefficients were established at  $p < 0.01$ .

**RESULTS**

Figure 1 shows the percentage distribution of caries prevalence for boys and girls. Sixty-six percent of boys and 67% of girls had decayed teeth. Table 1 shows the mean values of decayed tooth and plaque index and the results of *t*-test. There were no statistically significant

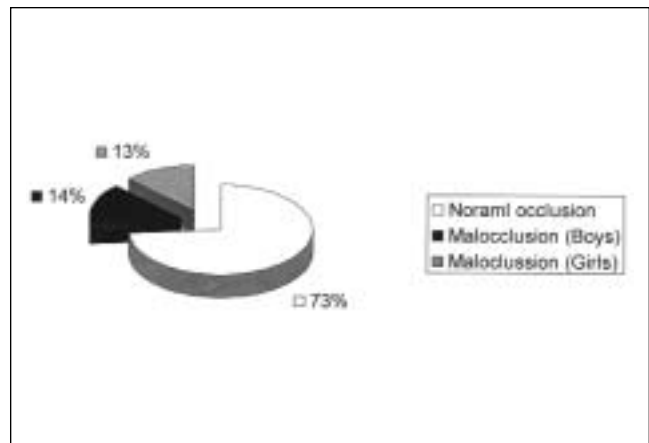


Figure 2.

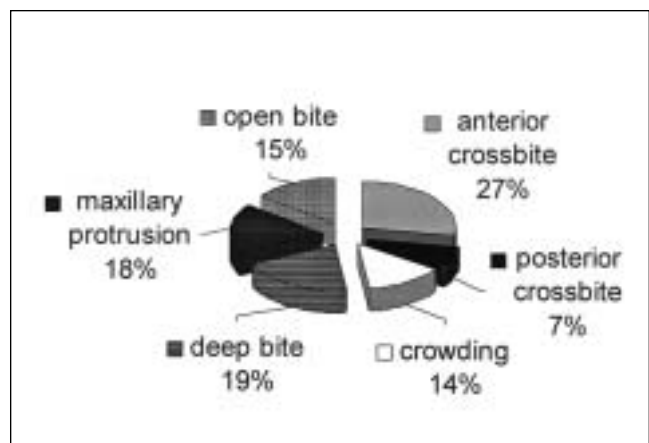


Figure 3

Table 1.

	Number of decayed tooth			Plaque index		
	Mean	SD	t-test	Mean	SD	t-test
Boys	4.351	3.555		2.008	0.746	
Girls	4.5941	3.550	NS	1.997	0.755	NS

differences in these two variables between boys and girls. The mean number of decayed teeth of all children was  $2.97 \pm 3.58$ , and the mean plaque index at the right maxillary central incisor was  $2.00 \pm 0.75$ . The percentage distributions of the prevalence of malocclusion are given in Figures 2 and 3. Twenty-seven percent of children had occlusal anomalies (14% were boys and 13% were girls). Anterior crossbite was the most frequently reported type, comprising 27% of the anomalies, followed by deep bite, maxillary protrusion, open bite, crowding, and posterior crossbite.

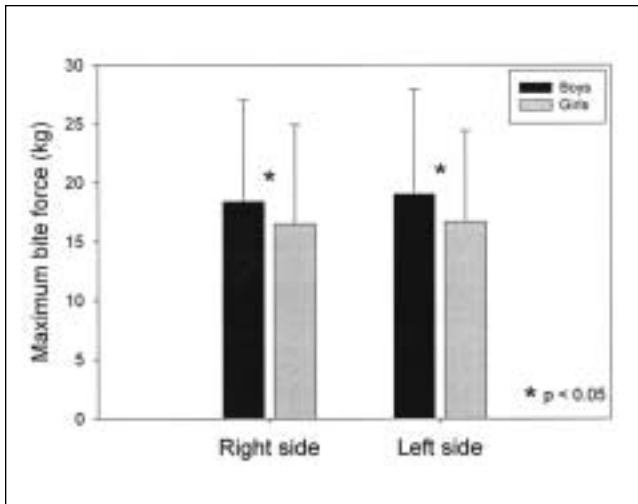


Figure 4.

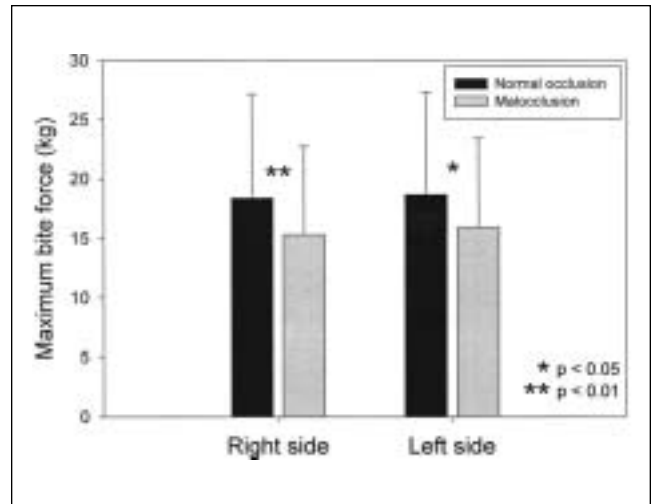


Figure 5.

Table 2.

	Number of decayed tooth	Plaque index	Maximum bite force (L)	Maximum bite force (R)
Number of decayed tooth		0.180 p < 0.001	-0.203 p < 0.001	-0.222 p < 0.001
Plaque Index			-0.135 p < 0.001	-0.159 p < 0.001
Maximum bite force (L)				0.726 p < 0.001
Maximum bite force (R)				

and girls and between normal and malocclusion for both the right and left sides. Correlation coefficients among the number of decayed teeth, plaque index, and maximum bite force are given in Table 2. There was a positive correlation between the number of decayed teeth and plaque index; however, there were negative correlations between maximum bite force and the number of decayed teeth and between maximum bite force and plaque index.

**DISCUSSION**

Several methodological components may have contributed to the variation in measured bite force such as the position of the bite force transducer, the inter-molar distance, the position of the mandible, and psychological factors. Painful decayed teeth, or just the fear of pain, may weaken the bite force because of a regulating reflex system or an even higher cortical control mechanism.<sup>10</sup> In addition to the periodontal feedback reflex, central states, e.g., the fear of pain due to dental decay, may also play a role in reducing the muscle force. The measurement of bite force is associated with technical errors and intra-individual variation. In order to minimize these sources of error, bite forces were measured three times for each child by a single investigator in this study.

Although Taichung City’s water supply is not fluoridated, the mean dt (2.97) in this study was close to the value (2.93) for Hong Kong (with fluoridated water).<sup>11</sup> The results of this study show that there was a negative correlation between maximum bite force and the number of decayed teeth. This suggests that having a decayed tooth is one of the factors affecting the health of the masticatory system in young children.

The magnitude of the maximal bite force depends on many variables including variation in jaw muscle size<sup>12</sup> and variation in craniofacial morphology.<sup>13</sup> The strength of the extremity muscles has been found to have a positive correlation with the cross-sectional area of the muscles.<sup>14</sup> Van Spronsen *et al.*<sup>12</sup> showed that the cross-sectional area of the masseter muscle, measured with either computed tomography or magnetic resonance imaging, correlated significantly with maximal bite force at the molars or the incisors. Earlier studies showed that adult males have a greater mean bite force than females.<sup>15-17</sup> The mean maximum bite forces measured in this study were larger in boys than in girls and were larger than those reported by Braun *et al.*<sup>18</sup> who studied 457 subjects from 6 years through 20 years in Austria. This suggests that there are sexual and racial differences in jaw muscle size and/or in craniofacial morphology.

Ingervall and Helkimo<sup>13</sup> found that higher bite forces correlated with a smaller cranial base flexure, a deeper upper face, a smaller anterior and a larger posterior face height, and a less divergent, broader face. Weijs and Hillen<sup>19</sup> found that a small jaw angle and short-faced persons have thicker masseter and temporalis muscles and, hence, have a stronger bite force. Anterior openbite and posterior crossbite have generally been reported to be the most prevalent anomalies of the primary occlusion in Caucasian children, with prevalences varying from 6% to 53% in anterior openbite and from 2% to 19% in posterior crossbite.<sup>20-22</sup> A difference in prevalence of occlusal anomalies was shown between Caucasian and Taiwanese children. Anterior crossbite was the most frequently reported one in this study, comprising 27% of the anomalies, followed by deep bite, maxillary protrusion, open bite, crowding, and posterior crossbite. The results of this study show that children with normal occlusion have a greater mean maximum bite force than children with malocclusion. This suggests that occlusion is also one of the factors affecting the health of the masticatory system in young children.

This study found that there were a negative correlation between maximum bite force and plaque index and a positive correlation between the number of decayed teeth and the plaque index. Further research is necessary to clarify the causes of the relationship between these factors and to evaluate other factors, which affect individual differences in bite force in young children.

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