Abstract: This study compared bite force in adults older than 60 years with that of young adults. The participants were 20 healthy adults (9 men) older than 60 years (median age, 66 years) and 44 healthy young adults (22 men; age range, 18-25 years; median age, 22 years) at the International Medical University, Malaysia. All participants had at least 20 teeth, and bite force was measured and evaluated using the Dental Prescale system. Average (SD) bite force was 420.5 (242.0) N for the older adults and 541.4 (296.3) N for the young adults. Although mean bite force was higher for the young adults, the difference was not significant. These findings suggest that bite force is unaffected by age in adults with adequate dentition. (J Oral Sci 58, 361-363, 2016)

Keywords: bite force; elderly; aging.

Introduction
Population aging was considered to be a concern mostly of developed countries and not of underdeveloped countries. However, the problem of aging populations in underdeveloped countries is becoming a serious issue. A study conducted by the Malaysian government found that Malaysia is in the third stage of demographic transition, in which the “population is aging due to its steady decline in birth rate” (Mahari Z, Othman WR, Khalili NMM, Esa S, Miskiman N. Demographic transition in Malaysia: the changing roles of women. In: 15th Conference of Commonwealth Statisticians, Government of India ministry of statistics and programme implementation ed, New Delhi, 2011:1-31). This demographic transition suggests a need for immediate attention to the needs of the aging population.

Bakke et al. (1) evaluated unilateral bite force in 63 females and 59 males aged 8 to 68 years and concluded that bite force decreased with age after age 25 years, in females, and after age 45 years, in males. Iinuma et al. (2) reported that maximum bite force was significantly associated with age in males. However, another study (3) of bite force in young adults (age 20-29 years) and 10 senior citizens with 28 teeth found no difference between the older and younger groups in total bite force distribution.

Among elders, mastication ability has direct and indirect effects on quality of life, particularly nutrition and health. Hence, the aim of this study was to evaluate age-related change in bite force among healthy men and women. We hypothesized that aging does not affect bite force in adults with adequate dentition.

Materials and Methods
Twenty healthy adults (9 men) older than 60 years (median age, 66 years) and 44 healthy young adults (22 men; median age, 22 years; age range, 18-25 years) from the International Medical University (IMU), Malaysia participated in this study. The young adults were included as a control group. The study was approved by the IMU Institutional Review Board (BDS 11-2010(01)2013@ys.xlsx), and all subjects provided written informed consent as part of the study protocol.

An oral examination was performed to verify that
participants fulfilled the study inclusion criterion, ie, presence of at least 20 natural teeth in the mouth. The exclusion criteria were presence of developmental anomalies (4), temporomandibular disease (5), a history of jaw injury or trauma (6), and periodontal pathologies (7).

Bite force was measured with an occlusal diagnostic system called the Dental Prescale system, which utilizes pressure-sensitive films (Fujifilm Corp., Kuala Lumpur, Malaysia) and a precalibrated scanning device (Dental Prescale/Occluzer, GC Corp., Tokyo, Japan). Before the measurement, subjects were seated comfortably on a dental chair in a natural unsupported posture looking forward, to the greatest extent possible, with the Frankfort horizontal plane parallel to the floor. The subjects were then asked to occlude repetitively in intercuspal position to ensure that the teeth were in maximal contact when they bit on the pressure-sensitive film, which is a horseshoe-shaped disposable sheet (thickness, 0.097 mm). All subjects were then asked to bite 3 times on the films for 3 s with maximum bite force. The average bite force was calculated from the two readings obtained. This occlusal force measurement technique has been well documented by Matsui et al. (1996) and Kurita et al. (2000) (8,9).

Differences in the magnitude of bite force manifested as variations in color densities on the films. A precalibrated scanning device was used to measure bite force by analyzing color densities on the foils.

The data were analyzed with the SPSS V18 statistical analysis software package (IBM SPSS Statistics, IBM Corporation, Armonk, New York, USA). Average bite force was compared between the two groups by using the independent-sample t-test ($P < 0.05$). Power analysis with the G-Power 3.1 software package (G*Power 2, Heinrich-Heine University, Dusseldorf, Germany) was used to determine the minimum sample size required to compare mean bite force in young and older adults. The proposed sample size of 64 (44 young adults and 20 elders) was more than adequate to investigate the main objective of this study.

### Results

Bite force (N) is expressed as occlusal contact area (mm$^2$) multiplied by occlusal pressure (MPa). The bite force of adults aged over 60 years varied widely (range, 185-1,200 N); the mean (SD) bite force was 420.5 (242) N. However, the average bite force of the young adults was 541.4 (296.3) N. Although the mean bite force of young adults was higher than that of the elders, the difference was not significant ($P = 0.0867$), as shown in Table 1. The average bite force was higher in men than in women, but the difference was not significant.

### Discussion

Several studies reported that bite force tends to increase during childhood and stabilizes after puberty. Bite force peaks at age 12 years, stabilizes after age 14 years, and declines slightly by age 17 years (10,11). To reduce sample bias, we included only patients aged 18 years or older in the present study.

A study that used the Prescale system to measure bite force in 46 Japanese (average age, 66.9 years) found that bite force was not associated with age in adults with many teeth (12). In the present study, bite force was also unaffected by age in healthy Malaysian elders with 20 or more teeth.

Decreases in muscle mass and strength may lead to diminished functional capacity in older adults (13). The cross-sectional area of the masticatory muscles is smaller in edentulous patients than in dentate subjects, regardless of age (14). The retention of natural teeth may result in reduced atrophy of masticatory muscles, as compared with edentulous individuals.

A previous study reported that bite force was significantly greater in men than in women and that it was related to physical fitness, movement ability, and lifestyle (12). The possibility that female sex is a risk factor for decreased mastication ability should be investigated in future studies.

The bite force of the present older adults varied widely (range, 185-1,200 N). A significant difference in bite force between healthy and frail elders was noted in a previous study (12). Thus, future studies may need to clarify

<table>
<thead>
<tr>
<th>Subjects (age, year)</th>
<th>Males</th>
<th>Females</th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elders (&gt;60) (n = 20)</td>
<td>526.2 ± 317.5 N (n = 9)</td>
<td>334.1 ± 111.2 N (n = 11)</td>
<td>420.5 ± 242.0 N</td>
</tr>
<tr>
<td>Young adults (18-25) (n = 44)</td>
<td>633.9 ± 320.9 N (n = 22)</td>
<td>448.9 ± 242.7 N (n = 22)</td>
<td>541.4 ± 296.3 N</td>
</tr>
</tbody>
</table>

*There were no significant differences between groups; "$P > 0.05$ for all comparisons".
participant health status on the day of measurement, even if all subjects are believed to be healthy elders.

Arnold (15) reported that the molars, premolars, and incisors have a bite force ratio of 4:2:1, i.e., the forces are much greater on the posteriormost teeth, which are close to the muscles producing the force. In present study, all elders had 20 or more teeth, including their posterior teeth, which, as compared with anterior teeth, bear greater bite forces during normal chewing. This greater force is a result of the lever effect of the mandible and the larger root supporting surface (bone and periodontal ligament) around the posterior teeth.

Usui et al. (16) studied the correlation between maximum bite force and mandibular plane angle in most age groups and noted an important relationship between the maximum bite force of various skeletal types and face shape, which was not considered in the present study. Future studies should thus include a larger sample and different face shapes, to ensure more precise results.

Despite the limitations of this study, we were able to determine that bite force was unaffected by age in adults with adequate dentition. This result further highlights the need to encourage adults to maintain healthy teeth for life, to preserve oral function and quality of life.

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References