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Lack of relationship between masticatory performance and nutritional status in adults with natural dentition

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ABSTRACT

Objective: This study assessed the relation among several aspects of the masticatory function and the nutritional status in adults with natural dentition.
Design: One hundred adults with natural dentition participated in this cross-sectional study. They performed one free-style masticatory test consisting of five trials of 20 silicon-chewing cycles. The preferred chewing side was determined by calculating the asymmetry index. Masticatory performance was determined by sieving the silicon particles, and the cycle duration was also recorded. Weight, body water percentage, body fat mass, muscle mass and osseous mass were measured using a portable digital weighing machine. Body mass index (BMI), waist-hip ratio, skinfold thickness and the upper-arm composition were determined. The relation between masticatory function and a nutritional variable were tested using Pearson or Spearman rank correlation coefficients or using analysis of variance or the Kruskal–Wallis H-test and the Mann–Whitney *U* test, as appropriate.
Results: Whereas body fat percentages for women were significantly higher than for men, the body mass index was higher in men than in women. Participants who were underweight chewed more asymmetrically and more slowly than normal weight or obese participants. A negative correlation was observed between body fat percentage and masticatory laterality. No relation between masticatory performance and any nutritional status indicator was detected.
Conclusion: Being underweight and having a low body fat percentage seem to be related to a masticatory lateral asymmetry and to a large cycle duration in young adults with natural dentition. Masticatory performance does not seem to be related to nutritional status.

1. Introduction

Nutrition is a general term for referring to the process of obtaining nutrients in food for health and growth. There are complex interactions between nutrition and oral and general health (Walls & Steele, 2004). The nutritional status is the state of the body in relation to the consumption and utilization of nutrients. Being overweight or obese is an important risk factor for morbidity from chronic diseases such as musculoskeletal disorders, cancers, diabetes and cardiovascular diseases. The body mass index (BMI) is normally used to assess being overweight and being obese, though percent body fat, waist-hip ratio and other anthropometric measurements are used as indicators of obesity (Panel, 1998). Several factors are normally involved in the generation of obesity, including genetic, physiological, metabolical, cultural, behavioral and social factors (Walls & Steele, 2004). Mastication is the first stage of digestion and is the process in which food is fragmented into small particles that are ready to be swallowed (Van der Bilt, 2011).

Oral function includes a number of phenomena such as masticatory performance, masticatory laterality or chewing rate. Masticatory performance can be determined by quantifying the degree of fragmentation of a test food after a fixed number of chewing cycles (Lujan-Climent et al., 2008; Van der Bilt & Fontijn-Tekamp, 2004). Dental silicone is considered the more appropriate

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test food (Edlund & Lamm, 1980), and silicon pieces placed in a latex bag have been demonstrated to be a reliable method for assessing masticatory function in dentate young adults with natural dentition (Rovira-Lastra, Flores-Orozco, Salsench, Peraire, & Martinez-Gomis, 2014). It is well known that the majority of people chew more on one particular side, i.e., they have a masticatory laterality (Diernberger, Bernhardt, Schwahn, & Kordass, 2008; Martinez-Gomis et al., 2009; Rovira-Lastra, Flores-Orozco, Ayuso-Montero, Peraire, & Martinez-Gomis, 2016). Although bilateral chewers were observed to chew more efficiently than unilateral chewers (Farias Gomes, Custodio, Moura Jufer, Del Bel Cury, & Rodrigues Garcia, 2010; Rovira-Lastra et al., 2014), no direct relation has been demonstrated (Rovira-Lastra et al., 2014). Chewing rate, defined as the frequency of chewing cycles per unit of time, seems to be remarkably stable within individuals, even across different days and foods (White et al., 2015). It has been found that eating slowly is associated with lower body mass index in middle-aged women (Leong, Madden, Gray, Waters, & Horwath, 2011).

Poor masticatory performance has been associated with both overweight and being underweight in children and with a lower mid-upper-arm circumference in the elderly (Okada, Enoki, Izawa, Iguchi, & Kuzuya, 2010; Tureli, Barbosa, & Gavião, 2010). However, apparently contradictory results have reported the relation between masticatory function and nutritional status in adults with natural dentition. Whereas the number of chewing cycles before swallowing was found to be negatively associated with BMI in a recent study, a positive association between BMI and the number of masticatory cycles was reported in another study (Sánchez-Ayala, Campanha, & Garcia, 2013; Zhu, & Hollis, 2015).

The main objective of this study was to determine the relationship between masticatory performance and the nutritional status in young adults with natural dentition. This study also assessed the relationship between masticatory laterality or chewing rate and the nutritional status in the same population. The null hypothesis was that masticatory performance is not associated with nutritional status.

2. Materials and methods

2.1. Subjects

Young adults with natural dentition among volunteer students and staff at the Faculty of Dentistry, Autonomous University of Nayarit, Tepic, Mexico participated in this cross-sectional study. Individuals with fewer than 24 natural teeth, without any edentulous space, those undergoing active orthodontic treatment and those suffering orofacial pain were excluded. No participant had severe malocclusion or temporomandibular disorders that could affect mandibular movement. Of the 103 participants who were invited to enroll in this study, three were excluded because of the lack of data. Thus, 100 participants were included, with a mean age of 21.9 years, and 53% of the sample were women. All participants provided written informed consent. The study was approved by the Ethics Committee of the Faculty of Medicine, Autonomous University of Nayarit, and all experiments were conducted in accordance with the principles of the Helsinki Declaration (World Medical Association, 2013).

2.2. Masticatory assays

The subjects were asked to chew naturally without imposing any side of the mouth for mastication and count their chewing cycles. A test medium known as “bagged silicone” was used for 20 cycles to comminute the pieces (Flores-Orozco, Rovira-Lastra, Willaert, Peraire, & Martinez-Gomis, 2016). Optosil tablets (5 mm thick, 20-mm diameter) were produced as described by Albert, Buschang, & Throckmorton (2003), and cut into quarters, and three quarters of a tablet was placed in a latex bag, which was sealed with cyanoacrylate adhesive (Rovira-Lastra et al., 2014). The masticatory assay was repeated four more times, and the particles from the five assays were collected to evaluate the masticatory performance. Particles from five trials were dried for 24 h and passed through a series of eight sieves (0.25, 0.425, 0.85, 2, 2.8, 3.35, 4, and 5.6 mm) while being shaken for 2 min (Lujan-Climent et al., 2008). After cumulative weight distribution of the sieves contents had been determined, median particle size was calculated for each subject using the Rosin–Rammler equation [$Qw\,(X) = 1 - 2E - (X/X_{50})^b$], where $Qw\,(X)$ is the fraction of particles by weight with a diameter smaller than X. The median particle size (X_{50}) is the size of a theoretical sieve through which 50% of the weight can pass, and b describes the broadness of the particle distribution (Olthoff, Van Der Bilt, Bosman, & Kleizen, 1984). Therefore, the lower the median particle size value, the better the masticatory performance.

To determine the preferred chewing side, one operator observed from the frontal plane on the side towards which the jaw moved while closing for each masticatory cycle. Therefore, each cycle was classified as right-, left- or no-side and recorded by means of two hand counters (Flores-Orozco, 2014; Flores-Orozco, Rovira-Lastra, Peraire, Salsench, & Martinez-Gomis, 2016). Questionable strokes were considered as no-side cycle. All masticatory cycles were considered to calculate the asymmetry index (AI) as follows: AI = (number of right strokes − number of left strokes)/(number of right strokes + number of left strokes) (Mizumori, Tsubakimoto, Iwasaki, & Nakamura, 2003). Masticatory laterality was considered as the absolute AI value. Therefore, values close to zero meant masticatory symmetry and values close to 1 meant masticatory asymmetry.

The total duration of the five masticatory assays was used to calculate the duration of an average chewing cycle (Salsench et al., 2005).

2.3. Anthropometric measurements

All subjects were fasting and with bare feet and comfortable clothing (underwear or sportswear) worn during measurements. Weight, height, body circumferences and skinfold thickness were recorded three times using standard procedures (Gibson, 2005). Weight, body water percentage, body fat mass, muscle mass and osseous mass were measured using a portable digital weighing machine (TANITA BC-553, Tanita Corporation of America Inc., Arlington Heights, Il USA). Height was measured using a wall mounted stadiometer (SECA 206, length of 2200 mm, accuracy 1 mm). Waist circumference was measured with a flexible tape MASS® (Accuracy 1 mm) in the time gap between the end of exhalation and the beginning of the inspiration of normal breathing, midway between lower edge of the tenth rib and the iliac crest. Mid-upper arm circumference (MAC) was taken at the point midway between the acromion and the radiale of the upper arm using a flexible tape on the left side. Skinfold thickness (biceps “BFS”, triceps “TFS”, subscapular “SSF”, suprailiaco “ISF”) were recorded following the criteria of Durnin and Womersley (1974) using a Slim Guide® skinfold caliper calibrated to exert a constant pressure of 10 gm/mm^2. The anthropometric measurements were collected by a previously calibrated single observer.

2.4. Assessment of body composition

Body mass index (BMI) was calculated as body weight divided by height squared. Waist-hip ratio (WWR) using a tape was determined as waist measurement divided by hip measurement.