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Chewing Duration Time of Various Food Textures in Young Adults

ORIGINAL

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Abstract

Background: Researchers in Speech Therapy usually state that the food texture consumed influences considerably the chewing time and that therefore it is important to understand the duration of this oral function for different food textures, in order to have a greater objectivity in the evaluations. Thus, normative and comparative patterns can be developed between different cases, with the intention of enriching the clinical practice and having scientific support that guides the speech-language pathology. So, the objective os this study was to obtain reference values of chewing time of several food textures in young adults.

Methods and Findings: descriptive study with a quantitative approach that was developed in a clinical reference, being the population composed of 40 young adults between 18-30 years of age, of both genres. As exclusion criteria: those with neuromuscular and/or degenerative diseases or consequences thereof, as well as subjects who were making use of any orthodontic/orthopedic resource. We conducted a dental evaluation, followed by a clinical assessment. One at a time, the following foods were offered: French bread, wafer biscuit, roasted cashews, for voluntary chewing. To measure the food chewing time, we used a stopwatch, and this collection procedure was filmed. Data analysis was performed by means of the *SPSS statistics 20.0 (IBM®) program.* There was a statistically significant difference ($p < 0.05$) between the medians of chewing time of French bread, wafer biscuit and cashew nuts, which were 33.0s (interquartile amplitude 29.0-40.0), 10.0s (interquartile amplitude 8.25-12.0) and 18.5s (interquartile amplitude 15.0-23.75), respectively.

Conclusions: The texture of foods influences the length of mastication. The more rigid is the food, the more cycles and mandibular movements, and therefore the longer chewing duration.

Keywords
Stomatognathic System; Chewing; Speech Therapy.

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Introduction

Some Phonoaudiology researchers often say that the texture of foods to be consumed greatly influences the chewing time, frequency and number of chewing cycles, since the foods' physical characteristics and their deformability during the grinding step are considered differentiators in mastication [1-4].

However, the consistence and texture terms, found in the literature, also generate controversy. Some authors describe that the texture refers to solid foods, while consistency is connected to semi-solid foods [5]. Even so, such concepts are not well defined in Phonoaudiology. For this study, the *texture* term was used referring to the sensory ability of food that is detected by the senses of touch (on hand and oral cavity), vision and hearing, manifesting when food undergoes physical deformation [6]. Within the Phonoaudiology, the deformation occurs when starting the chewing process.

Chewing is constituted as being the most important function of the stomatognathic system (SE) by contributing to its growth, development and health in general. This function aims to the degradation of food into smaller particles that, when mixed with the saliva, form the food bolus that will be able to be swallowed [7, 8].

For this function to occur properly it is necessary the existence of a structural and functional integrity of its components, whereas chewing suffers multifactor influence [1, 4, 9].

By having complex nature, the masticatory function has been much studied in recent years. However, there is still a lack of standardization in its evaluation process. It is known that, once the process of evaluation is committed, the diagnosis tends to be erroneous and the treatment will not be efficient, being therefore essential to evaluate every aspect of chewing, and therefore the duration of each masticatory act and cycle.

It is important to understand the duration of mastication for various food textures, to have greater objectivity in evaluations, in order that normative and comparative standards can be developed between different cases, to enrich clinical practice and have scientific backing to guide our action as speech therapists [1, 3, 2, 10].

Thus, to contribute to greater regulation and standardization of the mastication's evaluation process, the present study aimed to obtain reference values of chewing duration in young adults for different food textures.

Methods

This study is characterized by being descriptive-exploratory, of quantitative approach. The study was conducted in a clinical reference, and the sample of this study was composed of 40 young adults, allocated for convenience, aged between 18 and 30 years old, of both genres.

As exclusion criteria, were not considered those volunteers who submit degenerative and/or neuromuscular disease, or sequelae thereof, because they might interfere with the muscular coordination to perform the chewing of food; as well as subjects who were making use of any orthodontic or orthopedic apparatus.

Inclusion criteria were considered the subject who submitted at least 28 teeth and the first molar, to sort later as the occlusion by Angle classification.

Voluntary signed a free and clarified commitment term before being subjected to a brief dental evaluation, as shown in **Figure 1**. Then the speech therapy clinical assessment was performed by also specific protocol, as shown in **Figure 2**.

The volunteer was placed in normal postural position, comfortable, sitting on a chair with head and trunk upright, with his/her eyes directed forward.

Then, food was offered, one at a time, so that the volunteer proceed to chewing. To time the chewing of food, a stopwatch (Kadio brand, KD 1069 model) was used and were used: French bread, wafer (vitarela® brand, chocolate flavor),

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Figure 1: Data collection protocol in Dentistry.

DENTISTRY - PROTOCOL FOR DATA COLLECTION

Name: Date: ___/___/____	
Sex: (__) M ( ) F	Age: _____ years
Research participant: (__) teacher ( ) student ( ) UFPB´s employee	
CLINICAL EXAMS: • Dental health • Number of teeth • CPOD index • Angle's rank (__) Normoclusion ( ) Class 1 ( ) Class 2 ( ) Class 3	

Figure 2: Data collection protocol in Speeche Therapy.

SPEECH THERAPY - DATA COLLECTION PROTOCOL

Name:	
Profession:	
Date of birth: ___/___/___	Age: ___ years
Sex: (__) M ( ) F	Evaluation date: ___/___/___
PRELIMINARY INTERVIEW Are you allergic to any food? (__) Yes ( ) No Which food? _____ Have you eaten any of the foods below? ( ) French bread (__) Chocolate wafer type cookie ( ) Toasted cashew nuts Did you experience any type of allergic reaction after eating these foods? (__) Yes ( ) No	
MASTICATORY TIME EVALUATION Chewing food (filming and use of the timer - time in seconds / note only the third time performed):	
French bread -	
Chocolate wafer type cookie -	
Toasted cashew nuts -	
Space for notes needed	

roasted cashew nuts (and the bread was always baked in the assessment day and all food acquired and stored in the same location in the same way, to better control variables).

The French bread was selected because it is a food of easy acceptance, by clearly allow observation of the amplitude of the cycles and for being widely used in speech therapy chewing evaluation protocols, in general.

The wafer biscuit was selected for presenting different texture (crispness, that is, the property of some foods that emit a dry noise when cracking in the teeth; it is related to the moisture content of the cookie, the concentration of sugar used for flavoring and use of proper packing) and for enabling greater storage time without modification of its properties, when properly stored [2].

Still, the cashew nut was used, a tighter food, that requires more strength, more cycles and mandibular movements for its milling, and may thus require increased chewing duration [2].

Thus, for the volunteers, they were offered the above three foods in this order: French bread, wafer and toasted cashew nuts.

All foods were supplied under the same conditions, besides weighed and measured in their sizes. The French bread was broken into pieces and weighed, so that each of its parts presented weight between 12.5 and 15 grams. The wafer biscuit wafer was broken into 4 equal parts, so that the volunteer chewed ¼ per time. Six cashews crackers (medium size) were offered so that the subject chewed two nuts at a time.

For all this procedure, a Diamond VML brand digital scale was used, high precision (0.01g-500g) for weighing of the bread used in the evaluation.

The entire collection procedure was filmed by directing the focus of filming for regions in height between the head and shoulders, in the framework of the lower face, in the front position. The video camera was placed on a tripod, one meter and a half in relation to the back of the chair where the volunteer was sitting, with 2XWT of 16X zoom [10, 11].

The participant received food and, freely, one food at a time, introduced it in the oral cavity and held chewing, which was filmed and timed (in seconds) for three consecutive times for each food, considering the possibility of embarrassment by the voluntary, which could initially interfere with his/her performance [11].

For this research, it was considered the third duration of chewing food, considering that the volunteers could be embarrassed at first. And it is important to note that between each chewing phase, there was a break of 30 seconds, to avoid muscle fatigue.

For the analysis of the data obtained in the survey, it was used the *SPSS 20.0 (IBM®)* software. We used the following statistical tests: Shapiro-Wilk, Kruskal-Wallis, multiple comparison of Dunn and Spearman correlation.

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This study was approved by the Ethics Committee on Human Research of the Health Sciences Center (CCS) of the Federal University of Paraíba, under protocol number 0151/13.

Results

Of the 46 students who agreed to participate in the study, six were excluded due to tooth loss that compromised the minimum number of teeth needed to participate in the research. In this way, 40 individuals composed the sample, being evaluated as to oral health and the chewing time of three different food textures. Thirty-two participants (80%) were female. The average age was 21.1±2.61 years. The characteristics of the sample are described in **Table 1**.

Table 1. Characteristic of the 40 students sample of the Federal University of Paraíba.

	N	%
Female	32	80.0
	average ± standard	
Age (years)	21.1±2.61	
Number of present teeth	29.35±1.46	
CPO-D Index	6.77±3.53	
Decayed tooth	1.7±1.81	
Lost	0.35±0.83	
Sealed tooth	4.72±3.60	
Classification of occlusion	**N**	**%**
Normal	4	10
Class I	27	67.5
Class II	5	12.5
Class III	4	10

Chewing Time	N	p25-p75
Bread	33.0	29.0-40.0
Wafer	10.0	8.25-12.0
Chestnut	18.5	15.0-23.75

Variables expressed as absolute and relative frequency, average ± standard deviation or median and interquartile range amplitude (p25-p75).

For analysis of chewing time of the three types of food, the Shapiro-Wilk normality test was used. When observed the distribution of these data, a non-parametric test analysis of variance (Kruskal-Wallis test) showed statistical significance between the differences of evaluated medians ($p < 0.05$). A post-test (Dunn's multiple comparison test) showed a greater discrepancy between the chewing time of wafer and bread ($p < 0.05$). **Figure 3** shows these results.

Through the non-parametric Spearman test, it was verified that there was no correlation between the times of chewing and oral health (CPO-D), as well as its components, as shown in **Table 2**.

Figure 3: Time in seconds of chewing the foods with different consistencies, shown the medians, interquartile amplitudes and maximum and minimum values.

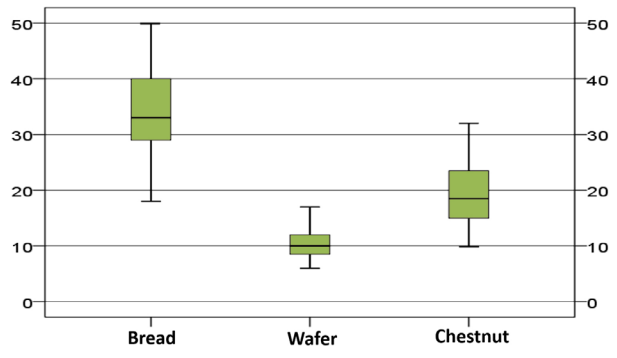

Table 2. Correlation (rho) and significance (p) between chewing times and CPO-D index and its components.

Variables	CPO-D		Decayed tooth		Lost		Sealed tooth	
	rho	P- value	rho	P- value	rho	P- value	rho	P- value
Bread	0.085	p>0.05	-0.014	p>0.05	0.088	p>0.05	0.081	p>0.05
Wafer	-0.016	p>0.05	-0.155	p>0.05	-0.038	p>0.05	0.067	p>0.05
Chestnut	-0.181	p>0.05	-0.080	p>0.05	0.128	p>0.05	-0.165	p>0.05

It was also observed that there was no significant correlation between chewing times and the key of dental occlusion, according to Angle's classification.

Discussion

For being a complex function, chewing has been the subject of many studies in recent years. Most of these studies points to the increase in growth in the number of referrals to phonoaudiological treatment, with the aim of correcting this stomatognathic function. Thus, there is a growing concern on the part of these professionals regarding the chewing evaluation process, since there is still a lack of standardization in this process, as well as there are no parameters of normality on several aspects that allow to compare different cases [2, 12].

Because it is a function that undergoes the influence of several factors, it is important to take caution, at the moment of evaluation, of aspects such as dentition and occlusion, saliva flow, bite force, craniofacial pattern, posture, musculature, the quantity and texture of food [1, 4, 2, 9].

Although these aspects influenced chewing, in our study no correlation was observed between these variables: decayed teeth, missing teeth and obturated teeth with the masticatory time variable. The lack of correlation between the decayed teeth and masticatory time variables can be explained by the fact that only dental caries, characterized by lesions and active white spots on the interproximal surfaces, were observed during the dental evaluation, which probably did not influence large proportions in chewing.

Regarding the variables: chewing time and missing teeth, the non-observation of correlation between them can be justified by the low number of subjects with dental losses, because the research was carried out with an audience of young adults with good dental conditions . This finding agrees with another research, held also with adult subjects, obtained as a result the lack of relationship between tooth loss and masticatory time [13].

There was also no correlation between obturated teeth and masticatory time. This can be justified by the fact of restorations, at the moment of the dental assessment, being in satisfactory conditions. In cases where restorations with fractures or infiltrations were observed, the subjects were inserted into the group of decayed teeth.

In our research there was also no correlation between masticatory time and the different occlusal classes of Angle. This result agrees with that of another study carried out by other authors [9] who evaluated the mastication of 45 individuals, being 15 without dentofacial deformity, 15 with diagnosis of class II dentofacial deformity and 15 with diagnosis of class III dentofacial deformity. The evaluation was done using a single food, cornstarch cookie, and the masticatory time was considered as the interval between placing food in the oral cavity until the final moment of swallowing of each portion. As a result, these authors describe that the dentofacial deformities did not influence the duration of mastication.

As discussed earlier, the amount, size and texture of the foods to be consumed considerably influence the chewing time, as well as the frequency and number of masticatory cycles. This relationship was observed during our study that showed statistical significance between the medians of the times ($p < 0.05$) for the three different textures separately, as well as when the medians of the times between two paired textures were compared ($p<0.05$). These findings are similar to the results obtained in the research of other authors [15].

When comparing the times for the three textures, French bread was the food that presented the greatest chewing time (33s) because of its size and its physical properties. It is known that the larger and more rigid the food, the greater the chewing time because it requires a greater number of cycles and

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mandibular movements so that an effective break of the food can be obtained, in order to make it possible the formation of the food bolus ready to be swallowed [1, 2 ,8, 14].

The physical characteristics of the food and its capacity of deformation during the grinding phase are considered differential factors among the foods, since the masticatory process fits and adapts to different food textures. In this way, it is important to use foods that have varied textures in the same amount during the clinical evaluation, so that it is possible to have comparison parameters [1, 2, 8].

Other studies also evaluated the chewing time using French bread, wafer biscuit and nuts. Some researchers [16] evaluated the chewing time in 20 elderly and 20 young adults, and it was observed that the masticatory time of 16 evaluated elderly was in the range of 30 seconds; in 3 elderly subjects the time ranged from 30 seconds to 1 minute; in only 1 elderly the time was less than 30 seconds. The control group with age between 25 and 30 years reached a maximum time of 20 seconds, with an average of 15 seconds. The difference between the average lengths of chewing bread duration, between our research and this one, can be explained or understood due to the fact that the authors did not specify the size or weight of bread used in the evaluation. The volunteers performed the incision as usual, and in our study the bread had a defined size and was introduced directly into the oral cavity.

Other researchers [17] also evaluated chewing with French bread and the parameter used to rate the masticatory rhythm was up to 15 seconds as fast, up to 20 seconds as normal and over 20 seconds as slow. Most of the evaluated subjects presented age near 60 years old, being observed a slow masticatory rhythm in 96.7% of the sample.

Speech therapists researchers [15] studied the chewing time, in seconds, for foods of different textures, and bread was the food that presented the longest duration (26.3 seconds) in relation to other foods tested, which corroborates with the findings of our study. The work also included banana, apple, chestnut, wafer biscuit and water-and-salt biscuit. The values of the masticatory times obtained for the wafer biscuit and for the chestnut were 15.4 and 11.6 seconds, respectively. It was observed a different result in our study, since we observed a longer time for the chestnut when compared to the masticatory time of the wafer biscuit. But the other times found for each food were similar in both studies.

The authors justify the use of these foods in the research because they are commonly used in clinical speech-language practice. However, they report that there are no studies on normal values for individuals without anatomic and functional abnormalities of the stomatognathic system and they emphasize the importance of having a masticatory time parameter for different food textures, so that they can be used in the clinic for subjects with impaired masticatory function. In addition, they suggest that during the chewing evaluation process, French bread and wafer biscuits are mainly used, since most studies on the subject use these two foods and therefore allow comparisons between different cases.

Other researchers, also speech therapists, [14] evaluated the chewing of adult subjects with and without temporomandibular dysfunction. They used French bread, apple, banana and cashew nuts and observed that the more rigid the food, the longer the chewing time for each act and cycle.

Phonoaudiology Teachers [18] developed a survey of 53 individuals of both genres, aged 42-67 years, divided into two groups, where group 1 was composed of 32 users of total or partial removable prosthesis, and group 2 was composed of non-users of prostheses. In the evaluation, the food used was the bread of salt (French bread) and the chewing time was determined in seconds. The average time between the beginning of the incisal phase and the beginning of the first swallowing in four consecutive sequences was taken into account. The findings

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showed that the time values found in individuals using prostheses (average: 22.07") are very close to values found in individuals with normal dentition (average: 19.06").

Different from the aforementioned studies, in our research, it is considered only the third chewing time. Considering the possibility of embarrassment on the part of the volunteer, at first, for not knowing the researchers and for being filmed during the execution of the function, which could interfere initially in their masticatory performance.

Speech therapists researchers [2] also suggest that the procedure to evaluate chewing time is repeated three times for each food to be sure of chewing time.

Some other studies describe chewing time, however they use other foods such as "water and salt" biscuit, banana and apple [19, 17, 14]. However, few studies investigate the duration of chewing with foods of different textures in adult subjects, most of them being carried out with children or elderly people, making it difficult to compare the discussion of the results observed in our study [18, 19, 20].

Therefore, it is suggested that other researches on the duration of chewing of foods with different textures in young adults should be developed with food standardization in relation to size and quantity, so that normative parameters can be established to compare different results obtained in clinical practice.

It is also suggested to carry out similar studies with a larger sample in order to observe possible correlations that were not observed in our study due to the number of subjects evaluated.

Conclusion

The reference values found in young adults for the three textures were different. The average time found in seconds for bread was of 33.0, for wafer biscuit was of 10.0 and for chestnut was of 18.5. From the results analyzed in this study, it was concluded that the food texture influences the duration of chewing. The more rigid the food, the greater the amount of cycles and mandibular movements and, consequently, the longer the duration of mastication independent of the Angle occlusion key and the variables of the CPOD index.

Contribution of authors

RCV worked on the phases of article elaboration, from project, design, database construction, analysis and interpretation of data, writing of the manuscript and concept map construction. JFFO, CS and ESP contributed in the phases of design, elaboration, delineation, database construction, data analysis and data interpretation and writing. AKFJA and DAOF performed manuscript guidance and critical review.

Interest conflict

The authors declare no conflict of interest.

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