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# Perceived Chewing Ability in Adults with or without Dentures

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Perceived Chewing Ability in Adults with or without Dentures

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DDS, Universidad Central de Venezuela, 2010

A Thesis

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APPROVAL PAGE

Master of Public Health Thesis

Perceived Chewing Ability in Adults with or without Dentures

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## Table of Contents

Introduction	1
Background	2
Methods	7
Results	11
Discussion	17
Conclusion	21
References	23
Appendix A	30
Appendix B.	31
Appendix C.	32

## List of Tables and Figures

Figure 1. Research Model	7
Figure 2. Distribution of Type of Dentures	14
Figure 3. Distribution of Perceived Denture Comfort	15
Table 1. Demographic and Health Characteristics of Dental Clinic Participants	12
Table 2. Characteristics of Participants by Denture Status	13
Table 3. Chewing Satisfaction and Difficulty Chewing by Denture Status	16
Table 4. Food Choices and Food Avoidance by Denture Status	17

## **Abstract**

**Background:** Masticatory impairment impacts both oral health as well as general health. Self-perceived chewing ability can be a tool to assess denture satisfaction, food choices and quality of life. **Objective:** To describe the perceived chewing ability with or without use of dentures in adults of different ages and implications in food choices. **Methods:** Administration of a 20-question survey to adult patients at the Advanced Education in General Dentistry (AEGD) residency clinic at the University of Connecticut School of Dental Medicine. **Results:** Chewing ability and food choices were significantly impacted by denture status ( $p = 0.015$ ). Denture status was significantly associated with education ( $p=0.043$ ). Perceived chewing ability was not associated with age. **Conclusion:** Denture status impacted chewing ability. Denture wearers presented increased difficulty chewing vegetables, fruits, meat and breads. Limited food choices could potentially impact their health. Education was significantly associated with denture status.

## **Introduction**

The oral cavity is the entryway for nutrient intake and the primary function of teeth is mastication.<sup>1</sup> One of the most immediate and important functional consequences of many oral disorders is a reduction in chewing ability.<sup>2</sup> The impact of the oral health status on daily life activities and the relationship between oral health and quality of life it is often not recognized by the population.<sup>3-5</sup>

Older adults seem to be more at risk of masticatory impairments due to partial or complete tooth loss.<sup>4,6-8</sup> Epidemiological studies show that persons of decreased socio-economic status and individuals with lower educational level regardless of age are more likely to have less teeth and therefore, masticatory impairment.<sup>10</sup> Studies also show that dental status in elders was associated with diminished perceived ability to eat a number of foods.<sup>7,9</sup>

There are many factors that can potentially influence food choice, such as socio-economic status, cultural beliefs and personal preference.<sup>9,11,12</sup> However, the physical ability to bite and chew is also very important.<sup>9,13</sup> Tooth loss and masticatory impairment would limit food choices and variety in the diet.<sup>9,14-16</sup> Moreover, the fabrication of removable dental prosthetic appliances (dentures) aims to restore masticatory function.<sup>17</sup> The ability to chew is not only an important dimension of oral health, but it is increasingly recognized as being associated with general health status.<sup>14,18,19</sup> Self-perceived chewing ability can be a tool to assess denture satisfaction, food choices and quality of life<sup>5,20</sup>.

The public health question that will be addressed with this research is the relationship between perceived chewing ability in adults with or without dentures at different ages and the implications for food choices.

## **Background**

Complete adult dentition consists of 32 teeth including the wisdom teeth. Partial edentulism is defined as the absence of some but not all of the natural teeth in a dental arch.<sup>21</sup> Edentulism refers to the complete absence of teeth and is considered a disability by the WHO in the latest International Classification of Functioning, Disability and Health (ICF).<sup>22</sup> More commonly, edentulism is the result of permanent tooth extraction in adulthood, which may or may not be due to caries, periodontal disease, trauma or other orofacial pathology.<sup>23</sup> Consensus among clinicians is that the larger the number of teeth retained, the better the chewing ability maintained.<sup>24</sup>

Chewing is considered the most important function of the stomatognathic system and indicates the ability to crush, grind and mix food with saliva, as well as the ability to form the bolus.<sup>25</sup> Thus, the act of chewing creates a relation of inter- dependence with nutrition.<sup>26</sup> In conceptual models of oral health, it is described how oral disorders or diseases will lead to five outcomes: impairment, functional limitation, pain/discomfort, disability and handicap.<sup>27,28</sup> Oral health diseases, including tooth loss, engross a complex set of variables including behavioral, environmental and social factors. Understanding these factors is key to develop high quality interventions that address the problem and improves the overall health of the population.<sup>29</sup>

Adults with fewer than 20 natural teeth have worse oral health related quality of life (OHRQL) than those with 20 teeth or more.<sup>17</sup> The World Dental Federation and WHO have proposed that adults should have at least 20 natural teeth for proper masticatory function.<sup>8,10</sup> The overall prevalence of edentulism in the general adult population in the US is 25% individuals over 65 years of age.<sup>10</sup> The older adult population appears to be more at increased risk for tooth loss.

Tooth loss is a worldwide public health issue, especially in low and middle-income countries. It has been comprehensively demonstrated that social, economic and environmental factors have a fundamental impact on oral health.<sup>32</sup> Theoretical approaches for oral health understanding and interventions explore the relationship between the social environment and health, hence, working towards the development of public health action on altering the underlying social determinants of health.<sup>33</sup> Oral health is associated with social determinants of health such as education, income and also in differences in opportunity, behaviors and beliefs.<sup>34</sup> The perceived masticatory ability appears to be related to dental status, denture quality, general health and a variety of personal determinants such as physiologic, social, economic, and psychological factors.<sup>35</sup>

Masticatory impairment impacts both dental health as well as general health.<sup>2,16,36,37</sup> Dysfunction in chewing ability is perceived as a serious oral health impairment, and has been found to be related to many other oral health problems when assessed with broad concepts such as Oral Health-Related Quality of Life (OHRQoL).<sup>2</sup> Tooth loss is associated with general health conditions such as blood pressure, obesity and a potential risk factor to cardiovascular disease.<sup>12,37,38</sup> Furthermore, it has been recognized that patients' perceptions of their oral health are important in evaluating well-being and determining health care outcomes.<sup>39</sup>

### *Dentures*

Restoration of partial and complete tooth loss is managed through treatments that involve fixed bridges, implant-supported removable dental prostheses, removable partial (RPD) and complete dentures (CD).<sup>17,22</sup> Implants are artificial root like screws inserted in the bone to provide stability for crowns, bridges or dentures.<sup>40</sup> An implant-supported overdenture is a removable complete denture combined with implants designed to improve stability in the oral environment.

<sup>41</sup> This type of oral rehabilitation offer the possibility of overcoming some of the functional limitations of regular dentures. <sup>42</sup>

Removable dentures are particularly frequent in developed nations. Some countries report that one-third to half of the older people wear full dentures while up to three-quarters wear removable full and/or partial dentures. <sup>10</sup> The prevalence of removable dentures shows considerable variation by socio-economic status the rates are high among the socio-economically disadvantaged. <sup>43</sup>

Various studies have assessed the effectiveness of different treatment options for the rehabilitation of edentulism. There are established standard criteria to evaluate dentures which include: retention, stability, speech, masticatory efficiency, comfort while eating food, confidence in intimate situations, satisfaction, and self-esteem. <sup>22</sup> Oral rehabilitation following total or partial tooth loss has also been shown to lead to significant improvement in quality of life. <sup>17</sup>

Although dental prostheses are an artificial substitute for the teeth and may perform a similar function, the use of dental prostheses and/or unadjusted prostheses might not provide the patient with comfort and a satisfactory masticatory function. <sup>26</sup> Wearing dentures could be a factor influencing specific dietary patterns as well. It has been reported that chewing ability is compromised with the use of dentures. In a comparison of people with replaced teeth and with natural teeth, persons with tooth replacement showed higher rates for chewing problems. <sup>15</sup>

#### *Chewing Ability, Food Choices and Dietary Implications*

Dietary choices are the consequence of a wide array of factors such as social and cultural background, financial resources, food security, time, taste preference, transportation, knowledge and skills. <sup>44</sup> Nonetheless, the presence of adequate functional natural teeth may influence nutrition and health by affecting the way food is prepared, as well as by affecting food choices. <sup>9</sup>

When fewer natural teeth are present, older adults tend to develop food choice habits based around foods that are softer and easier to chew. These soft foods are often low in nutrients and fiber but high in calories and carbohydrates.<sup>11</sup>

Adults with masticatory dysfunction may have poor diet quality due to limitations on their choice of foods.<sup>14,45</sup> The dietary pattern in persons with chewing difficulty tends to include foods that are soft and easy to masticate, which often contain a higher concentration of sugar and fat.<sup>12</sup> These food choices may increase the risk for chronic diseases such as diabetes and hypertension.<sup>39,46</sup> Individuals with impaired masticatory ability have been reported to avoid foods that are difficult to chew, including raw vegetables or fruits, well-done meats and dried breads.<sup>9,12,47</sup> Adequate intake of raw fruits and vegetables constitute sources of fiber and vitamins that have been related to prevention of diabetes, cardiovascular disease, cancer and other systemic conditions.<sup>18,36,48</sup>

A study in dentate and edentulous participants showed that perceived chewing ability increased with increasing number of teeth.<sup>9</sup> Perceived chewing ability and avoidance of dry solid foods, such as bread, were related to the number of molar tooth pairs in the study of older adults.<sup>16</sup> Lee et al<sup>1</sup> surveyed 954 subjects in Taiwan and reported that poor nutritional status and quality of life were found in persons with poor self-perceived chewing ability.<sup>1</sup> Moreover, self-reported assessment of chewing ability has been shown to be simple, informative, and valid.<sup>24,49</sup>

Chewing ability has been found to be closely correlated to the number of residual teeth, but a loss of up to seven teeth did not seem to entail an assessment of impairment.<sup>50</sup> Samnieng et al<sup>16</sup> reported that fewer number of teeth was significantly associated with limited food choices in older participants. Consequently, limited food choices increased the risk of malnutrition. A study of 83,104 women concluded that those with fewer teeth have healthier diets with decreased

intake of fruits and vegetables, thus increasing risk for cardiovascular disease.<sup>36</sup> Another study conducted in the UK concluded that adults with considerable tooth loss (possessing less than 20 teeth) but who did not have recourse to a denture were among those with the poorest oral health-related quality of life in the population after controlling for socio-demographic factors.<sup>51</sup>

According to the observations of Agerberg & Carlsson<sup>50</sup> in 1981, one-fourth of the complete denture wearers in their study reported that they could not chew all sorts of food. Adults and older adults who wear unadjusted prostheses prefer foods with a softer consistency and have a higher prevalence of experiencing inadequate chewing.<sup>26</sup> Goel et al<sup>52</sup> found that consumption of fruits, vegetables, and salads increased after rehabilitation with dentures and the improvement in diet was highest in rehabilitated completely edentulous participants.

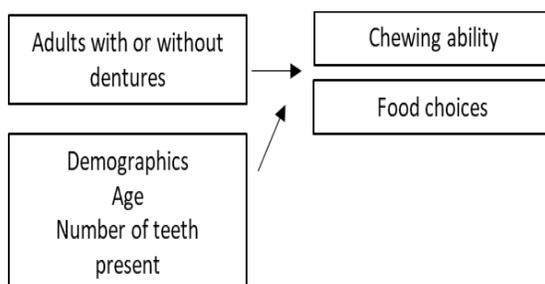
Allen and Mc Millan<sup>42</sup> reported that patients who had problems with dentures and who received implant prostheses showed improved chewing ability and food selection. However, a number of patients who received implant prostheses did not change their food selection.<sup>42</sup> Their findings suggested that, in the absence of dietary counseling, apparently successful prosthetic rehabilitation does not necessarily result in a satisfactory diet.

Most studies about chewing ability have only focused on older adult population.<sup>4,9,14,53</sup> Iwasaki et al<sup>30</sup> studied 80-year-old adults in Japan and described how dietary intake was poorer in those with self-perceived ill-fitting dentures. Although, it seems like older adults would be at risk for masticatory impairment, the actual relationship of perceived chewing ability and food choices at different ages has not been properly explored. Furthermore, detection of oral health problems related to chewing ability can help to assist oral health care providers in preventing and addressing chewing difficulties by identifying the factors associated with impaired oral function.<sup>20</sup>

## Specific Aims

The research objectives for the study were to determine if the perceived chewing ability varies with or without use of dentures; concomitantly, we aimed to describe the perceived chewing ability and chewing satisfaction in adults of different ages and finally to examine the association of perceived chewing ability and food choices in adults (Figure 1).

**Figure 1.** *Research Logic Model.*



The hypotheses guiding the research were the following:

H1: Perceived chewing ability varies in persons with or without wearing dentures

H2: Chewing ability decreases in adults 65 years and older

H3: Perceived chewing ability impacts food choices

## Methods

### *Research Design*

The approach taken in this study was descriptive cross-sectional. The purpose was to collect self-reported health data and identify characteristics of the population that attend to dental care. A self-administered survey was distributed to patients in the waiting area at the Advanced Education in General Dentistry (AEGD) residency clinic at the University of Connecticut School of Dental Medicine between February and March 2019.

The AEGD Dental Clinic services includes general dentistry, screening clinic and dental emergency. The clinic is located at the University of Connecticut Health Center (UConn Health) at Farmington campus and serves patient's demographics comprised of 83% White, 11% African American, 2% Asian, and 4% Other <sup>1</sup>. A study flyer (Appendix A) was designed and posted in the waiting area of Main Dental Clinic with information regarding the research and invitation for participation.

Eligible subjects were male and female adult patients over 18 years old that attended for dental appointments at UConn School of Dental Medicine in Farmington. Inclusion criteria involved ability to provide consent for participation and ability to read and write the English language. For the purpose of this study we were interested in the individual as the unit of analysis to understand behavior and oral health.

A total of 48 patients were recruited into the study through convenience sampling. We targeted 24 dentures wearers and 24 non denture wearers. From 48 surveys obtained, only 40 were considered complete and were included for the study.

### *Survey Instrument*

A survey instrument was designed applying questions from the National Health and Nutrition Examination Survey, the Oral Health Questionnaire for Adults by the WHO and previous surveys developed in this field. <sup>9,13,54</sup> The survey consisted of 20 questions that collected demographic, general health, denture status, chewing ability and satisfaction information from respondents (Appendix C). The survey was designed to take approximately five to ten minutes to complete. Participation was voluntary and no compensation was offered. Each survey had a cover letter with information about the study and instructions for participants (Appendix B). No

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<sup>1</sup> <https://health.uconn.edu/graduate-medical-education/patient-population/>

personal identifiers were asked for the survey and only the investigators had access to the completed surveys and the data remained in safe lockers and desks at all times.

The administration of a research survey has been used in past studies to gather information about chewing ability and nutritional habits.<sup>5,46,54,55</sup> Over the years, several authors have assessed the validity of self-reported oral health responses, concluding that self-reports a valid measure, although the accuracy of data varies with the degree of specificity required; the more specific the question, the less accuracy of answers provided.<sup>57-59</sup>

The study protocol and survey were compliant with the UConn Health Institutional Review Board (IRB) and classified as exempt under the *Category 2 (research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observations of public behavior*<sup>2</sup>.

#### *Variables*

The key independent variable in the study was the use of dentures. The dependent variables assessed were chewing ability and food choices. Covariates were age, number of teeth, education, race or ethnicity, hypertension, diabetes and smoking status.

Denture status was assessed by asking participants whether they had dentures and, if so, which type (upper and lower complete dentures, upper and lower partial dentures or combinations between those type of dentures).

Chewing ability and satisfaction with or without dentures were assessed by the two questions below scored from 1 to 7 (validated in previous studies by Gilbert et al<sup>24</sup> and Tsakos<sup>55</sup>), to represent the degree of comfort and satisfaction respectively:

1. How comfortable are your dentures when you bite and chew?

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<sup>2</sup> <https://ovpr.uconn.edu/services/rics/irb/submission-process/>

Extremely uncomfortable, very uncomfortable, Somewhat uncomfortable, neutral, somewhat comfortable, very comfortable, extremely comfortable.

2. What is your overall chewing satisfaction?

Extremely dissatisfied, very dissatisfied, somewhat dissatisfied, neutral, somewhat satisfied, very satisfied, extremely satisfied.

A five-point Likert scale was used to assess the difficulty chewing including nine categories of common foods, previously used in studies by Allen et al<sup>42</sup>, Sheiham & Steele<sup>9</sup>, Tsakos et al<sup>55</sup>:

- Raw vegetables such as carrots, broccoli, celery, kale, peppers.
- Starchy vegetables such as potato, sweet potato, squash.
- Cooked vegetables (boiled, canned).
- Meats such as steak, chicken, lamb.
- Fresh fruits such as apples, pears, strawberries, peaches.
- Canned or processed fruits.
- Dried nuts such as almonds, peanuts, walnuts.
- Beans such as black beans, chickpeas, pinto beans, lentils.
- Bread such as crusty bread, toasts, bagels.

*Statistical analysis*

Data analysis started with the input of all survey responses into an Excel datasheet file, coding and assigning numbers for easier calculation. Each variable was analyzed by denture status using frequencies and percentages for ordinal/categorical variables and mean and standard deviation for continuous variables. Groups with denture and without denture were compared with respect to each variable by Fisher's exact test for categorical variables and by Wilcoxon rank-

sum test for ordinal and continuous variables. Food choices and denture status were compared using a linear regression model. A p-value smaller than 0.05 was deemed to be statistically significant. All the statistical analyses were performed in R 3.5.0.

## **Results**

A total of 48 surveys were returned by patients in the dental clinic. Eight surveys were removed due to missing key data, 40 completed surveys were included in the analysis, including 20 from denture wearers and 20 from non-denture wearers. As shown in Table 1, 55% participants were women and 40% of the sample were 65 or older, 30% between 50 to 64 years old, 30% were 30 years or younger. Regarding race and ethnicity, 65% of respondents were white, 15% black or African American and 12% Hispanic or Latinos (Table 1). The majority (68%) of respondents from the survey reported having at least some college education (45%).

Thirty eight percent of participants reported having public insurance, 36% were uninsured, and 25% reported either employee sponsored or private insurance. Forty percent of respondents said they had hypertension and 20% presented with diabetes. One in five participants reported being smokers.

More than half (55%) of participants that reported denture use were 65 years and older (Table 2). Of those who reported denture use, half were female. Thirty seven percent reported public insurance and 37% being uninsured. Regarding education and denture status, 55% of those with dentures reported having at least some college.

The majority (60%) of those with dentures have less than 9 teeth. Forty five percent of denture users had hypertension and 30% diabetes. No statistical difference was found between groups except for education level ( $p = .043$ ) and number of teeth ( $p < 0.001$ ) (Table 2).

**Table 1. Demographic and Health Characteristics of Dental Clinic Participants**

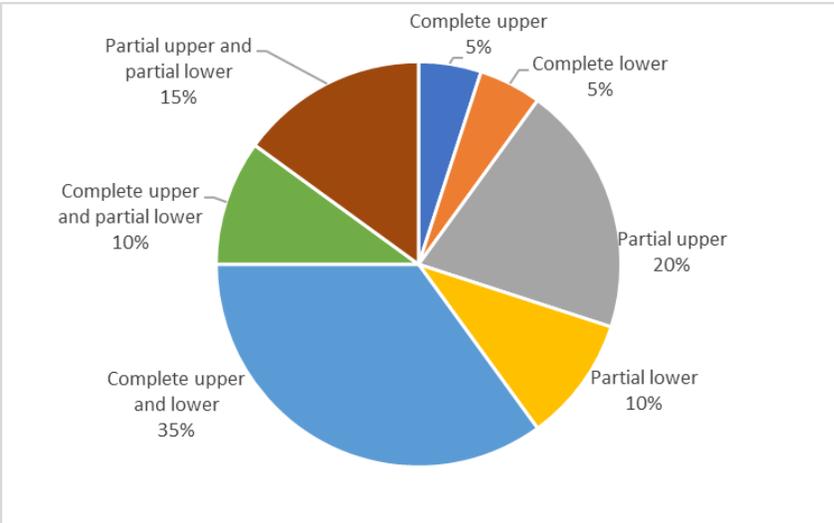
Question	Total Sample (n=40)
<b>Age</b>	
18-29	1 (2%)
30-49	11 (28%)
50-64	12 (30%)
65 older	16 (40%)
<b>Gender</b>	
F	22 (55%)
M	18 (45%)
<b>Race/Ethnicity</b>	
Hispanic	5 (12%)
Black african	6 (15%)
White	26 (65%)
American Indian	0 (0%)
Asian	2 (5%)
Native Hawaiian	0 (0%)
Two or more races	1 (2%)
<b>Education</b>	
Less than high school	1 (2%)
High school	12 (30%)
Some college	18 (45%)
College graduate	2 (5%)
Graduate school	7 (18%)
<b>Type of Dental Insurance</b>	
Medicaid	15 (38%)
Employee sponsored	6 (15%)
Private	4 (10%)
Uninsured	14 (36%)
<b>Hypertension</b>	
Y	16 (40%)
N	24 (60%)
<b>Diabetes Mellitus</b>	
Y	8 (20%)
N	32 (80%)
<b>Smoking Status</b>	
Non smoker	20 (50%)
Smoker	10 (25%)
Former smoker	10 (25%)
<b>Number of teeth</b>	
No teeth	7 (18%)
1 to 9 teeth	6 (15%)
10 to 19 teeth	14 (35%)
20 or more teeth	13 (32%)

**Table 2. Characteristics of Participants by Denture Status**

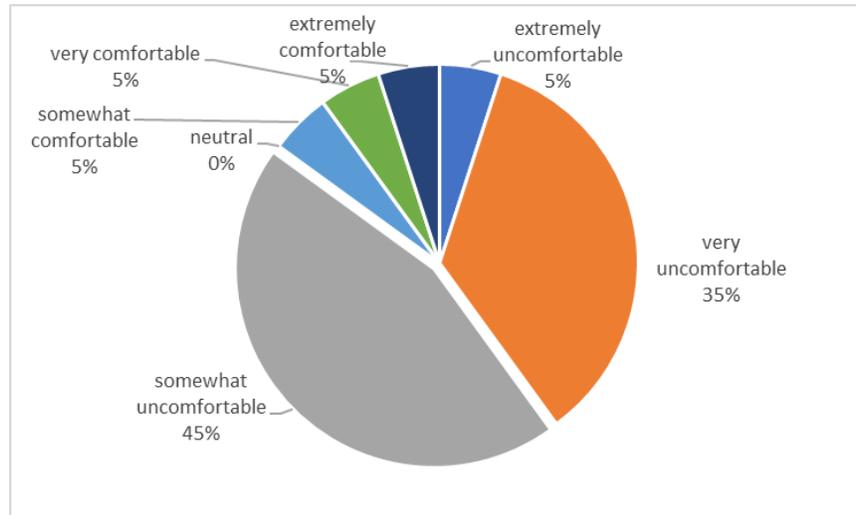
Question	With Denture (n=20)	No Denture (n=20)	p-values
<b>Age</b>			0.108
18-29	0%	5%	
30-49	25%	30%	
50-64	20%	40%	
65 older	55%	25%	
<b>Gender</b>			0.751
F	50%	12%	
M	50%	40%	
<b>Race/Ethnicity</b>			0.327
Hispanic	5%	20%	
Black african	15%	15%	
White	70%	60%	
American Indian	0%	0%	
Asian	10%	0%	
Native Hawaiian	0%	0%	
Two or more races	0%	5%	
<b>Education</b>			0.043
Less than high school	0%	5%	
High school	45%	15%	
Some college	45%	45%	
College graduate	5%	5%	
Graduate school	5%	30%	
<b>Type of Dental Insurance</b>			0.089
Medicaid	37%	40%	
Employee sponsored	5%	25%	
Private	21%	0%	
Uninsured	37%	35%	
<b>Hypertension</b>			0.748
Y	45%	35%	
N	55%	65%	
<b>Diabetes Mellitus</b>			0.235
Y	30%	10%	
N	70%	90%	
<b>Smoking Status</b>			0.915
Non smoker	45%	55%	
Smoker	25%	25%	
Former smoker	30%	20%	
<b>Number of teeth</b>			< 0.001
No teeth	35%	0%	
1 to 9 teeth	25%	5%	
10 to 19 teeth	40%	30%	
20 or more teeth	0%	65%	

Among denture wearers, the most common type of denture found were the combination of complete upper and complete lower denture (35%), (Figure 2). Only three (2%) respondents reported having implant supported dentures and only one reported to be extremely comfortable with his/her dentures and felt neutral about chewing satisfaction. Sixty percent of denture users reported having the denture for one year or more, 20% from 3 to 6 months, 15% for 6 months to 1 year and only 5% having dentures for less than 1 month. When asked about their denture comfort, 45% reported being “somewhat uncomfortable” and 35% “very uncomfortable” (Figure 3).

**Figure 2.** *Distribution of Type of Dentures*



**Figure 2.** *Distribution of Perceived Denture Comfort*



When participants were asked for reason for dissatisfaction with chewing, missing teeth was the most common response (40%), followed by ill-fitting dentures (20%). Other less popular reasons were painful teeth (12%) and gum pain (12%). Denture status was significantly associated with number of teeth ( $p < 0.001$ ) and education ( $p = 0.043$ ) (Table 2). Patients with no dentures had higher level of education and more teeth. Avoiding foods and making food choices based on chewing ability was reported by 68% of the participants (Table 4).

Chewing satisfaction and difficulty chewing foods were highly correlated (Pearson correlation coefficient = 0.81). Both were significantly associated with denture status by Wilcoxon rank sum test with no adjustment for other covariates ( $p$ -values = 0.015) (Table 3). Those with dentures reported more difficulty with all food types.

**Table 3.** *Chewing Satisfaction and Difficulty Chewing Foods by Denture Status*

	With Denture (20)	No Denture (20)	Total (40)	p-value
<b>Chewing satisfaction</b>	2.8 ± 1.44	4.45 ± 2.19	3.62 ± 2.01	0.015
<b>Difficulty level chewing</b>				
Raw vegetables such as carrots, broccoli, celery, kale, peppers.	1.9 ± 0.79	3.35 ± 1.53	2.62 ± 1.41	0.003
Starchy vegetables such as potato, sweet potato, squash	3.7 ± 0.8	4.1 ± 0.97	3.9 ± 0.9	0.143
Cooked vegetables (boiled, canned)	3.7 ± 0.92	4.15 ± 0.88	3.92 ± 0.92	0.143
Meats such as steak, chicken, lamb.	2.25 ± 1.12	3.35 ± 1.46	2.8 ± 1.4	0.019
Fresh fruits such as apples, pears, strawberries, peaches.	2.45 ± 1.28	3.45 ± 1.28	2.95 ± 1.36	0.018
Canned or processed fruits	3.6 ± 0.99	4.15 ± 0.88	3.88 ± 0.97	0.089
Dried nuts such as almonds, peanuts, walnuts	1.85 ± 1.23	3.2 ± 1.4	2.52 ± 1.47	0.002
Beans such as black beans, chickpeas, pinto beans, lentils	3.45 ± 0.89	4.1 ± 0.97	3.77 ± 0.97	0.035
Bread such as crusty bread, toasts, bagels	2.6 ± 1.1	3.4 ± 1.43	3 ± 1.32	0.076

More difficulty chewing raw vegetables, meats, fruits such as apples, nuts and crusty breads was significantly associated with denture status and some remained statistically significant after adjusting for education in a linear regression model ( $p < 0.05$ ). As seen in Table 4, 95% of participants with dentures reported avoidance of foods and making food decisions based on chewing ability. The differences found for both questions between the two groups were statistically significant ( $p\text{-value} < 0.001$ ). Moreover, making food decisions and avoiding certain foods based on chewing ability were not associated with age ( $p\text{-value} = 0.561$ ) but were associated with number of teeth ( $p\text{-value} < 0.001$ ).

**Table 4.** *Food Choices and Food Avoidance by Denture Status*

	With Denture (20)	No Denture (20)	Total (40)	p value
<b>Do you make food choices based on you chewing ability?</b>				< 0.001
YES	95%	40%	68%	
NO	5%	60%	32%	
<b>Do you avoid foods because chewing/biting them is difficult?</b>				< 0.001
YES	95%	40%	68%	
NO	5%	60%	32%	

## Discussion

In this study, associations between a self-perceived chewing ability and food avoidance were found in adults with or without dentures. Similar results have been found by Altenhoevel et al<sup>3</sup>, Baumgarten et al<sup>26</sup>, Khalifa et al<sup>20</sup>, Zhang et al<sup>15</sup>. Making food decisions and avoiding certain foods based on chewing ability were not associated with age but they were associated with a greater number of teeth. According to Sheiham and Steele's<sup>9</sup> findings, perceived chewing ability increased with increasing number of teeth. It is likely that in our study denture status is a mediator in the association between number of teeth and chewing ability.

The patient's demographic obtained in the survey is representative for the dental clinic where the study was conducted. The majority of respondents being White, followed by Black and Hispanic minorities. Our results cannot be generalized to the overall American population. There is lack of information in the literature regarding denture status and chewing ability by racial groups. In terms of edentulism, data analysis from the National Health and Nutrition Examination Survey of 2011–2012, reported that among adults aged 65 and over, complete tooth loss was lower for older Hispanic (15%) and non-Hispanic white (17%) adults compared with older non-Hispanic black adults (29%). Some authors have explored edentulism and diet, such as study in a

biracial community found that edentulism was more strongly linked to dietary intake in whites than in blacks.<sup>45</sup>

Complete dentures were the most frequent type of denture found in this study, followed by upper partial denture. This trend is consistent with studies by Savoca et al<sup>60</sup> and Inukai et al.<sup>19</sup>. It is important to take into account that the number of teeth missing will determine the type of denture, therefore persons with no teeth will require complete dentures. The most frequent reasons for chewing dissatisfaction were missing teeth and ill-fitting dentures. This finding is consistent with studies by Altenhoevel et al<sup>3</sup> and Baran et al<sup>62</sup>. Additionally, patients wearing dentures were more likely to make food choices based on their chewing ability and avoid certain foods because chewing/biting them is difficult. Baumgarten et al,<sup>26</sup> found that adults and older individuals who wear unadjusted prostheses prefer foods with a softer consistency and have a higher prevalence of experiencing inadequate chewing.

It has been reported in previous studies<sup>41,42,61</sup> that prostheses that are retained on implants offer the possibility of overcoming some of the limitations of conventional dentures in terms of chewing efficiency. However, despite reporting improvement in satisfaction in regard to comfort and ability to chew foods, around 50% of persons with implant supported dentures still avoided eating foods such as carrots and apples.<sup>42</sup> Apparently successful prosthetic rehabilitation does not necessarily result in improved diet. Since our results for implant supported dentures were not significant, further studies with larger samples including implant supported dentures are required in order to understand this relationship.

Education was found to be significantly associated with denture status. Patients with no dentures tended to have more education and more teeth. Concomitantly, chewing ability measured by chewing satisfaction and by difficulty chewing foods were significantly associated with

denture status and education. Similar to findings by Savoca et al,<sup>60</sup> persons who avoided the most foods were more often those with lower education and income. Education and other socioeconomic variables are intrinsically connected with oral health status;<sup>32,33</sup> hence the significant association of education with dentures and total number of teeth. Perhaps those with more education will have more resources to prevent tooth loss and avoid requiring dentures.

The present study found that the majority of denture wearers were 65 years or older. Chewing satisfaction, food decisions and avoiding certain foods based on chewing ability were not associated with age but were associated with number of teeth. This finding differs to multiple studies in this field where increased age is associated with a greater likelihood of difficulty in chewing.<sup>6,7,26,30,31</sup> In our study, adults with fewer teeth regardless of age seem to experience less chewing satisfaction, although the small sample size could explain the lack of a statistical finding.

According to Baumgarten et al,<sup>26</sup> aging process leads to changes both neurological and anatomical and may result in decreased neuromuscular activity, reflexes, sensitivity and saliva production. The oral health of the elderly also has a great influence, being strongly related to the presence of cavities, periodontitis, xerostomia, tooth loss and/or unadjusted prostheses.<sup>31</sup> Difficulties in chewing, discomforts with dentures as well as ill-fitting dentures of poor quality are common among the elderly.<sup>3</sup>

More difficulty chewing raw vegetables, meats, fruits such as apples, nuts and crusty breads was found to be significantly associated with denture status. There was a tendency for persons with dentures to consume fewer fruits and raw vegetables. Despite the fact that we provided a standard list of foods used in previous studies in this field,<sup>13,55,63</sup> we should take into account that personal and cultural differences could affect responses to food related questions. Answers to open- ended question “please specify foods you avoid because eating them is

difficult” were inconclusive due to the large amount of missing data, nonetheless, eight of the 21 who did respond, reported avoiding steak, apples, vegetables and granola.

Improvements to the diets of older adults through prosthodontic treatment and preventing tooth loss have been reported.<sup>9,22,42</sup> Goel et al.<sup>52</sup> concluded that improvement in diet was highest in rehabilitated completely edentulous participants followed by participants with partial dentures. Moreover, it has been also reported that tooth loss and type of prosthesis do not affect the acceptability of food.<sup>35,64</sup> In studies of nutrition in adult populations adults who wear partial and complete dentures have a diet lacking in fiber and vitamins.<sup>55,63,65</sup> The reasons for this are thought to be difficulty in chewing raw vegetables and fruits. They also reported that those with severe tooth loss had the lowest dietary quality and avoided the most foods.<sup>26</sup> In our study we did not assess nutritional status of participants, therefore no assumptions can be made about nutrition. However, the intrinsic relationship of nutrition and food choices has been well documented in previous studies.<sup>48,55</sup> Further studies assessing the relationship of dentures, nutrition and chronic health conditions should be considered.

### *Study Limitations*

The main limitation of this study was the sample size being small and the patient population being from a single clinic. We also should account for the possible role of confounders in the hypothesized associations, especially demographics. Due to the distribution of racial groups in the study, the results are not generalizable to the U.S. population. The survey was distributed only in English, preventing those with other languages to participate. Additionally, cultural differences and dietary behaviors could also be potential confounders in this type of study.

Assessment of clinical factors that could potentially impact perceived chewing ability, such as occlusion, dry mouth and temporomandibular joint disorders were not evaluated in this

study. We recommend designing a research model that includes clinical assessment to fully understand the variables implicated in chewing ability. Education seems to be a factor intrinsically related to denture status and oral health; we recommend expanding the research accounting for socio-economic variables. Further studies with larger samples and longitudinal assessment for nutritional status with or without use of dentures are necessary to understand the impact of perceived chewing ability in health.

## **Conclusion**

This study aimed to assess chewing ability in adults of different ages with or without dentures and describe the impact on food choices. Chewing ability and perceived difficulty on chewing raw vegetables, fruits such as apples, pears, meat, nuts and crusty bread were significantly associated with denture status. Avoidance of foods and food choices were not associated with age but with the total number of teeth present in the mouth. Denture wearers reported more difficulty chewing all food types and also reported avoidance of foods. We found a significant association between education and denture status. Patients without dentures tended to have more education and more teeth. Socioeconomic determinants seem to play a role in denture status and should be taken into consideration for further studies.

Given that aging is a natural process, the preservation of healthy remaining teeth plays an important role in the maintenance of masticatory function of the middle-aged and elderly population. Perceived chewing ability is an important factor in enabling adults to consume diverse foods and perhaps improve their nutrition. It is clear that denture status impacts chewing ability and food choices potentially affecting nutrition and, therefore physical health. Preventing tooth loss and improving chewing ability are essential to attain a better quality of life. Furthermore,

results from this study enhance the importance of education programs to improve oral health behaviors and prevention of tooth loss.

Findings from this study confirm that clinicians must improve the assessment and management of patients with chewing difficulty. The role of dental professionals in preventative dentistry, oral health education and addressing problems with dentures relies on the implementation of best practices in dentistry adapted to the needs of the population at risk. Public health interventions in this area require participation of diverse health disciplines such as nutrition and medicine to aid in providing patients with dietary recommendations and nutritional guidance.

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**University of Connecticut**  
**Volunteers Wanted for a Research Study**  
**Perceived Chewing Ability in Adults with or without Dentures**

We are exploring the perceived chewing ability in adults from different ages who wear and don't wear dentures and the impact in their food choices. This information will help us develop further recommendations for providers to improve assessment and treatment of patients in our dental service.

Participation in the research is through a questionnaire survey that can be completed in 5- 10 minutes. Participation is voluntary and anonymous.

Eligibility:

Adults 18 and older

Ability to read and write English language.

If you are interested in participating in this research, please ask the Main Dental Clinic front desk. They will provide you an envelope with the questionnaire survey for you to fill out. Attached to the survey is a cover letter with detailed instructions.

For more information and inquiries contact Dr. Mara Cuberos, DDS at phone: 860- 679-0802 or via email: cuberosguevara@uchc.edu.

This research is conducted under the direction of Dr Geraldine Weinstein, DDS, available at phone: 860-679-6367.

## Appendix B. Survey Cover Letter

*IRB Review*  
*IRB NUMBER: 19X-109-2*  
*IRB APPROVAL DATE: 02/08/2019*

01/28/2019

Dear Patient,

I am a second-year dental resident at the University of Connecticut School of Dental Medicine doing research as part of a project required for my Master's in Public Health degree. The principal investigator for this study is: Dr. Geraldine Weinstein.

The title of this study is Perceived Chewing Ability in Adults with or without Dentures. We are exploring the perceived chewing ability in adults from different ages who wear and don't wear dentures. Additionally, we will be assessing the relationship of chewing ability and food choices in adults. We aim to obtain information about how adults perceive their chewing ability and satisfaction in order to better understand the association between teeth, dentures and food choices. This information will help us develop further recommendations for providers to improve assessment and provide better care.

You are invited to participate in this study on perceived chewing ability. Your participation is voluntary, anonymous and will be maintained in strict confidence. If you choose to participate, please complete the enclosed survey. You can stop completing the survey at any time. While complete surveys will provide better data, you may skip questions that you do not feel comfortable answering. Your response to these questions should take between 5-10 minutes to complete. After completion, please place the survey back in the envelope and deposit it in the marked box located at the front desk. Completion and return of this survey signifies your consent to participate in the study. Please do not place your name or date of birth on any of the sheets or envelope.

I appreciate your participation in this research study. For any questions regarding the study, please feel free to e-mail me at [cuberosguevara@uchc.edu](mailto:cuberosguevara@uchc.edu), or call me at 860- 679-0802 or call the Principal investigator at 860-679-6367.

Thank you.

Sincerely,

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Mara F. Cuberos Guevara, D.D.S.

Dental Resident & Masters of Public Health Candidate

University of Connecticut

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Geraldine Weinstein, D.D.S.

Associate Professor, Clinical instructor – General Dentistry

University of Connecticut

Version 2.0

## Appendix C. Survey

*IRB Review*  
*IRB NUMBER: 19X-109-2*  
*IRB APPROVAL DATE: 02/08/2019*

Title: Perceived Chewing Ability in Adults with or without Dentures

Please answer the following questions and circle the most appropriate response.

1. What is your age?
  - a. 18 – 29
  - b. 30 – 49
  - c. 50- 64
  - d. 65 – older
  
2. What is your gender?
  - a. Female
  - b. Male
  
3. To which racial or ethnic group(s) do you most identify? (Mark more than one if applicable)
  - a. Hispanic or Latino
  - b. Black or African American
  - c. White
  - d. American Indian or Alaskan Native
  - e. Asian
  - f. Native Hawaiian or other Pacific Islander
  - g. Two or more races
  
4. What is your highest degree of education?
  - a. Less than High School
  - b. High School Graduate
  - c. Some College

Version 2.0 (02/04/2019)

- d. College Graduate
  - e. Graduate School
5. What kind of dental insurance do you have?
- a. Medicaid/ Medicare
  - b. Employee Sponsored
  - c. Private
  - d. Uninsured
6. Have you been diagnosed with high blood pressure? YES NO
7. Have you been diagnosed with Diabetes? YES NO
8. What is your smoking status?
- a. Non-smoker
  - b. Smoker
  - c. Former smoker
9. How many natural teeth do you have?
- a. No teeth
  - b. 1 to 9 teeth
  - c. 10 to 19 teeth
  - d. 20 or more teeth
10. Do you wear dentures? YES NO

If YES, answer question #11, #12, #13 and #14

If NO, proceed to question #15

11. What type of dentures do you wear? (Select all that apply)
- a. Complete upper denture
  - b. Complete lower denture
  - c. Partial upper denture
  - d. Partial lower denture
12. Are these dentures supported by implants? (A dental implant is an artificial root made of titanium metal inserted into the jawbone) YES NO
13. How long have you had these dentures?
- a. Less than 3 months
  - b. 3 to 6 months
  - c. 6 months to 1 year
  - d. More than 1 year
14. How comfortable are your dentures when you bite and chew? (Select the most appropriate answer)
- a. Extremely uncomfortable
  - b. Very uncomfortable
  - c. Somewhat uncomfortable
  - d. Neutral
  - e. Somewhat comfortable
  - f. Very comfortable
  - g. Extremely comfortable
15. What is your overall chewing satisfaction? (Select the most appropriate answer).
- a. Extremely dissatisfied

- b. Very dissatisfied
- c. Somewhat dissatisfied
- d. Neutral
- e. Somewhat satisfied
- f. Very satisfied
- g. Extremely satisfied

16. If you are dissatisfied with your chewing ability, please indicate why (Select all that apply)

- a. Missing teeth
- b. Painful teeth
- c. Gum pain
- d. Other \_\_\_\_\_

17. Do you make food choices based on your chewing ability? YES NO

18. Do you find yourself avoiding certain foods because chewing/biting them is difficult?  
 YES NO

19. Please specify these foods you avoid because of difficulty chewing/biting

\_\_\_\_\_

20. How would you describe your level difficulty eating the following foods?

Raw vegetables such as carrots, broccoli, celery, kale, peppers.	Very difficult <input type="checkbox"/>	Difficult <input type="checkbox"/>	Neutral <input type="checkbox"/>	Easy <input type="checkbox"/>	Very easy <input type="checkbox"/>
Starchy vegetables such as potato, sweet potato, squash	Very difficult <input type="checkbox"/>	Difficult <input type="checkbox"/>	Neutral <input type="checkbox"/>	Easy <input type="checkbox"/>	Very easy <input type="checkbox"/>

Cooked vegetables (boiled, canned)	Very difficult <input type="checkbox"/>	Difficult <input type="checkbox"/>	Neutral <input type="checkbox"/>	Easy <input type="checkbox"/>	Very easy <input type="checkbox"/>
Meats such as steak, chicken, lamb.	Very difficult <input type="checkbox"/>	Difficult <input type="checkbox"/>	Neutral <input type="checkbox"/>	Easy <input type="checkbox"/>	Very easy <input type="checkbox"/>
Fresh fruits such as apples, pears, strawberries, peaches.	Very difficult <input type="checkbox"/>	Difficult <input type="checkbox"/>	Neutral <input type="checkbox"/>	Easy <input type="checkbox"/>	Very easy <input type="checkbox"/>
Canned or processed fruits	Very difficult <input type="checkbox"/>	Difficult <input type="checkbox"/>	Neutral <input type="checkbox"/>	Easy <input type="checkbox"/>	Very easy <input type="checkbox"/>
Dried nuts such as almonds, peanuts, walnuts	Very difficult <input type="checkbox"/>	Difficult <input type="checkbox"/>	Neutral <input type="checkbox"/>	Easy <input type="checkbox"/>	Very easy <input type="checkbox"/>
Beans such as black beans, chickpeas, pinto beans, lentils	Very difficult <input type="checkbox"/>	Difficult <input type="checkbox"/>	Neutral <input type="checkbox"/>	Easy <input type="checkbox"/>	Very easy <input type="checkbox"/>
Bread such as crusty bread, toasts, bagels	Very difficult <input type="checkbox"/>	Difficult <input type="checkbox"/>	Neutral <input type="checkbox"/>	Easy <input type="checkbox"/>	Very easy <input type="checkbox"/>