Accepted: 3 March 2024

DOI: 10.1111/ger.12747

ORIGINAL ARTICLE

Gerodontology WILEY

Dentition and weight status in community-dwelling older adults

Rena Zelig[1,2] | Amy Lyon[1] | Riva Touger-Decker[1,2] | Steven R. Singer[2] | Hamed Samavat[1]

[1]Department of Clinical and Preventive Nutrition Sciences, Rutgers School of Health Professions, Newark, New Jersey, USA

[2]Department of Diagnostic Sciences, Rutgers School of Dental Medicine, Newark, New Jersey, USA

Correspondence
Rena Zelig, Department of Clinical and Preventive Nutrition Sciences, Rutgers School of Health Professions, 65 Bergen Street #157, Newark, NJ 07107, USA.
Email: zeligre@shp.rutgers.edu

Background/Objective: Tooth loss is common among older adults and can affect dietary intake and weight status. This study investigated associations between dentition status and body mass index (BMI) in older adults.

Materials and Methods: This was a cross-sectional study of data from a convenience sample of older adults (65–89 years) treated at an urban U.S. dental school clinic. Clinical and demographic data were obtained from electronic health records. Dentition status was determined based on data from odontograms. Multinomial logistic regression was used to estimate the odds ratio (OR) and 95% confidence interval (CI) of having a non-normal weight status for each measure of dentition status, after adjusting for covariates.

Results: Patients ($n = 1765$) were 54.1% female, 51.5% White, 41.6% African American and 22.5% Hispanic/Latino. The median (interquartile range [IQR]) age was 71 (67.0–75.0) years; the mean (±SD) BMI was 28.5 (±5.7) kg/m^2; 72.5% were overweight or obese. The median (IQR) number of remaining teeth was 20.0 (13.0–24.0); the median numbers of anterior and posterior occluding pairs of teeth were 5.0 (2.0–6.0) and 2.0 (0.0–5.0), respectively; and 44.9% had a functional dentition (≥21 teeth). Having a higher number of remaining teeth and more posterior occluding pairs were associated with lower odds of obesity (OR = 0.980, 95% CI = 0.964, 0.997, $p = .022$ and OR = 0.931, 95% CI = 0.885, 0.980, $p = .006$, respectively). Lack of a functional dentition was associated with higher odds of obesity (OR = 1.400, 95% CI = 1.078, 1.818, $p = .012$), after controlling for covariates.

Conclusion: Older adults with tooth loss - especially loss of posterior occlusion and lack of a functional dentition - were more likely to be obese than of normal weight.

KEYWORDS
ageing, body mass index, geriatrics, nutritional status, occlusion, oral health, tooth loss

1 | INTRODUCTION

Tooth loss is a common problem faced by adults aged 65 years and older.[1–3] Approximately 30% of older adults worldwide are edentulous.[4] By contrast, approximately 17% of U.S. older adults are edentulous, and 55% lack a functional dentition (defined by Dye et al. as the presence of at least 21 remaining teeth).[3] While the overall prevalence of edentulism is decreasing, racial, ethnic and socioeconomic disparities put specific populations at higher risk of tooth loss.[3] Furthermore, tooth loss is a progressive condition that develops over the life course and is multifaceted in its aetiology.[5] While the adaptive response to tooth loss differs among individuals, tooth loss and oral dysfunction significantly affect the ability to bite, chew and swallow, negatively impacting appetite, diet quality, nutrient intake, eating-related quality of life (ERQOL), weight and nutrition status.[6–17]

Concurrent with oral dysfunction, the risk of malnutrition is higher among older adults.[18–20] According to the World Health Organisation (WHO), malnutrition "refers to deficiencies or excesses in nutrient intake, imbalance of essential nutrients, or impaired nutrient utilization. The double burden of malnutrition consists of both undernutrition and overweight and obesity, as well as diet-related noncommunicable diseases".[21] Progressive tooth loss (and edentulism, its endpoint) can lead to unintentional weight changes and malnutrition.[10,12–17] Impaired dentition and subsequent difficulty in biting and chewing can lead to suboptimal micronutrient, protein and energy intake due to food avoidance, and this may result in unintentional weight and body composition changes and a higher risk of malnutrition.[13–15] Nutrient-dense foods high in fibre (such as fresh fruits, vegetables, nuts, grains and some protein sources) are avoided by many older people due to difficulty biting and chewing, which can lead to weight loss and loss of muscle mass.[6,7,12] At the same time, tooth loss and subsequent oral dysfunction can also lead to a shift in the types of foods consumed, as well as higher intake of calorically dense higher fat, sugar and calorie foods, resulting in weight gain and obesity.[10,12,16]

These changes in diet seen in older adults with tooth loss, including a lower intake of protein-rich foods, can also negatively impact body composition, leading to sarcopenia (the loss of muscle mass and function).[20–24] Although sarcopenia can occur with or without obesity, sarcopenic obesity is "the co-existence of excess adiposity and low muscle mass".[23] Moynihan and Teo's scoping review of oral function, protein intake and sarcopenia found that tooth loss negatively impacts protein intake, and this can lead to reduced muscle mass.[22] In turn, this reduced muscle mass may affect masseter muscle function, thus decreasing chewing ability.[22] While not the subject of this research, the association between sarcopenia, obesity and tooth loss merits mention, because it is one of several potential causes of why older adults with tooth loss and obesity can be at risk of malnutrition and loss of muscle, which further exacerbates oral dysfunction.[22]

While there is a substantial body of research on dentition status, nutrition and weight status, there has been a paucity of U.S. research on the associations between dentition status and weight status in older adults in the past two decades. In 2003, Sahyoun et al.[6] explored the association between the number of posterior occluding pairs of teeth and nutritional status among U.S. older adults and found that those with 5–8 posterior occluding pairs had a lower mean BMI (27.2 kg/m^2) than those with 1–4 posterior occluding pairs (28.0 kg/m^2),[6] but, both mean BMI values were in the overweight range (25.0–29.9 kg/m^2).

Different approaches have been used globally to define and categorise tooth loss and anterior and posterior occluding pairs of teeth and, subsequently, analyse the associations between dentition and weight status. Gaewkhiew et al. (Thailand, 2019),[25] Torres et al. (Brazil, 2013),[26] Perera et al. (Sri Lanka, 2012),[27] and Sheiham et al. (United Kingdom, 2002)[28] found that poorer dentition status, more missing teeth, a lack of a functional dentition and fewer posterior or anterior occluding pairs of teeth (with or without denture use) were associated with a higher likelihood of being underweight. Hilgert et al. (Brazil, 2009),[29] Torres et al. (Brazil, 2013),[26] and Sheiham et al. (United Kingdom, 2002)[28] found that poor dentition status, be it more missing teeth or lack of a functional dentition (with or without denture use) were associated with a higher likelihood of being overweight or obese, while Gaewkhiew et al. (Thailand, 2019)[25] found no associations between dentition status and obesity.

With the continued challenges of tooth loss, obesity (with or without sarcopenia) and malnutrition among older adults, further studies are needed to elucidate the associations and consider appropriate interventions. Accordingly, the primary aim of this study was to investigate the associations between dentition status (assessed as the number of remaining teeth, anterior and posterior occluding pairs of teeth and the presence of a functional dentition) and weight status (as measured by BMI) in community-dwelling older adults treated at an urban school of dental medicine clinic in the northeast U.S. Given the heterogeneity of previous findings,[25–29] we hypothesised that there would be no associations between BMI and measures of dentition status including (1) the number of remaining teeth, (2) the number of anterior occluding pairs of teeth, (3) the number of posterior occluding pairs of teeth and (4) having a functional dentition.

2 | MATERIALS AND METHODS

This was a cross-sectional study of data from a convenience sample of older adult patients seen in an urban northeastern U.S. dental school clinic between July 2016 and April 2022. The sample was limited to all patients 65–89 years of age who had complete data to calculate their BMI and complete odontograms (dental charts) to enable assessment of dentition status. Patient records that were missing demographic information but had BMI and dentition data were included in the analyses. This study was approved by the institution's institutional review board (IRB) (Protocol #2021000687).

All data were collected as part of routine care and were obtained in an electronic report from the clinics' electronic health records

(EHRs) (Axium, EXAN, Vancouver, BC, Canada).[30,31] Patient height was obtained by student dentists in the clinic using a stadiometer or was self-reported by the patient. Weight was either obtained by the assigned student dentist using a digital scale or was self-reported by the patient. Height and weight were used to calculate BMI by dividing weight (measured in kilograms) by height squared (measured in metres). BMI was reported and analysed as both a continuous and categorical variable.

The number of remaining teeth was reported as a continuous variable from 0 to 28 (third molars were excluded from analyses).[18] The number of anterior and posterior occluding pairs of teeth was coded based on the presence of both the upper and corresponding lower teeth of the occluding pair.[18] The total number of anterior occluding pairs of teeth was reported on a scale of 0 to 6, including the incisor and canine teeth.[18] The total number of posterior occluding pairs of teeth was reported on a scale of 0 to 8, including the tooth surfaces distal to the right and left canine teeth and two sets of premolars and first and second molars (but not the third molars).[18] The presence of a functional dentition (defined as having ≥21 teeth)[3] was analysed as a dichotomous variable (present or absent) calculated from the total number of remaining teeth. Denture type (partial or complete and maxillary or mandibular) was also noted.

2.1 | Statistical analyses

Categorical variables were presented as frequencies (%). Histogram plots, box plots and the Kolmogorov–Smirnov tests were used to inspect continuous data for normality of data distribution. Median and interquartile range (IQR) were presented for data that were not normally distributed. Weight status as the outcome of interest was assessed using BMI categories in line with Center for Disease Control (CDC) criteria[32] and included: underweight <18.50 kg/m^2, normal weight 18.5–24.99 kg/m^2, overweight 25.0–29.99 kg/m^2 and obese ≥30.0 kg/m^2. Extreme values for BMI, including those with BMI <12 kg/m^2 or ≥100 kg/m^2, were excluded according to the established method of the Behavioural Risk Factor Surveillance System.[33] BMI was considered the dependent variable, while dentition status was the independent variable.

We used multinomial logistic regression models to determine the association between dentition status measures and weight status. Separate models were constructed for each of the dentition status measures as the primary independent variables of the study. Results were presented as odds ratios (OR) with 95% confidence intervals (CIs) for unadjusted and adjusted models. Covariates were determined by clinical relevance and examining bivariate analyses (Kruskal–Wallis and chi-square tests) between demographic and clinical characteristics and weight status categories as the outcome variable. Covariates included in the multivariable model were age, gender (male/female/transgender), presence of gastrointestinal disorders (yes/no), cardiovascular diseases (yes/no) and diabetes (yes/no). Since data for race and ethnicity were missing for more than 50% of the sample, we excluded these variables from the multivariable regression models. Normal weight status was considered as the reference category.

Since this study was a secondary analysis of existing data, an a priori power analysis was not conducted. An a priori alpha level was set at <0.05, and all statistical analyses used SPSS version 28.0 (IBM Inc., Armonk, NY).

3 | RESULTS

The study sample included 1765 records of patients aged 65–89 years old seen for a dental examination with complete BMI and odontogram data. Table 1 includes the demographic and clinical characteristics of the total sample, presented by BMI categories. The mean (±SD) BMI of the sample was 28.5 (±5.7) kg/m^2 (range = 13.2–67.4 kg/m^2); 72.5% of the sample had a BMI consistent with overweight or obesity.[34] Those with obesity had the lowest median age, were primarily female and non-Hispanic, and had the highest proportion of self-reported diabetes and cardiovascular diseases.

Table 2 summarises the dentition status of the sample by BMI category. Those with obesity had fewer remaining teeth, fewer posterior occluding pairs and were more likely to lack a functional dentition, than those who were of normal weight. In contrast, patients who were underweight had the fewest remaining teeth, and anterior occluding pairs, and were the most likely to lack a functional dentition than any other weight group. However, the sample of underweight patients was very small and these differences did not reach statistical significance.

Table 3 details the results of the multinomial logistic regression models used to determine the association between dentition and weight status. Findings were consistent in both unadjusted and adjusted models. A higher number of remaining teeth and posterior occluding pairs of teeth were associated with lower odds of obesity. At the same time, lack of a functional dentition was associated with a higher likelihood of obesity. Each additional remaining tooth was associated with 2.0% lower odds of being obese than of being normal weight after adjusting for age, gender and the presence of gastrointestinal disorders, cardiovascular diseases and diabetes. Similarly, after adjusting for covariates, each additional number of posterior occluding pairs was associated with 7% lower odds of being obese than of normal weight. Those who lacked a functional dentition had 1.4 times greater odds of obesity than patients with a functional dentition in the adjusted model.

4 | DISCUSSION

The primary aim of this study was to investigate associations between dentition status and weight status in community-dwelling older adults treated at an urban school of dental medicine clinic in the northeast U.S. We hypothesised that there would be no associations between BMI and measures of dentition status, including (1) the number of remaining teeth, (2) the number of anterior occluding

TABLE 1 BMI categories by demographic and clinical characteristics ($N = 1765$).

Characteristic	Total ($n = 1765$)	Underweight (<18.50 kg/m^2) ($n = 25$)	Normal 18.5–24.99 kg/m^2) ($n = 460$)	Overweight (25–29.99 kg/m^2) ($n = 717$)	Obese (≥30 kg/m^2) ($n = 563$)	*p* value
Age (n = 1765)[a]	71.0 (67.0–75.0)	73.0 (68.0, 80.0)	71.0 (67.0, 76.0)	71.0 (68.0, 75.0)	70.0 (67.0, 75.0)	.012
Gender ($n = 1765$)						
Female	954 (54.1)	11 (44.0)	251 (54.6)	351 (49.0)	341 (60.6)	<.001
Male	810 (45.9)	14 (56.0)	209 (45.4)	365 (50.9)	222 (39.4)	
Transgender	1 (0.1)	0 (0.0)	0 (0.0)	1 (0.1)	0 (0.0)	
Race ($n = 873$)						
White	450 (51.5)	4 (28.6)	105 (47.7)	194 (56.6)	147 (49.7)	<.001
Black/African American	363 (41.6)	9 (64.3)	85 (38.6)	127 (37.0)	142 (48.0)	
Asian	48 (5.5)	1 (7.1)	26 (11.8)	17 (5.0)	4 (1.4)	
Native Hawaiian/Pacific Island	10 (1.1)	0 (0.0)	4 (1.8)	4 (1.2)	2 (0.7)	
More than one race	2 (0.2)	0 (0.0)	0 (0.0)	1 (0.3)	1 (0.3)	
Ethnicity ($n = 806$)						
Non-Hispanic/Non-Latino	625 (77.5)	11 (100.0)	145 (77.1)	254 (77.2)	215 (77.3)	.369
Hispanic/Latino	181 (22.5)	0 (0.0)	43 (22.9)	75 (22.8)	63 (22.7)	
Select self-reported medical conditions						
Presence of cardiovascular diseases[b] (n = 1746)						
No	536 (30.7)	13 (54.2)	172 (37.7)	222 (31.4)	129 (23.1)	<.001
Yes	1210 (69.3)	11 (45.8)	284 (62.3)	485 (68.6)	430 (76.9)	
Presence of diabetes (n = 1765)						
No	1224 (69.3)	22 (88.0)	364 (79.1)	509 (71.0)	329 (58.4)	<.001
Yes	541 (30.7)	3 (12.0)	96 (20.9)	208 (29.0)	234 (41.6)	
Presence of GI disorder (n = 1732)						
No	1272 (73.4)	17 (68.0)	359 (79.2)	515 (73.4)	381 (69.0)	.003
Yes	460 (26.6)	8 (32.0)	94 (20.8)	187 (26.6)	171 (31.0)	

Note: Values are frequencies (%) unless otherwise noted. Percentages may not add up to 100% due to rounding. *p* values are based on the Kruskal–Wallis test for age variables and chi-square or Fisher's exact test for categorical variables.

Abbreviations: BMI, body mass index; GI, gastrointestinal.

[a]Values are median (quartile 1–quartile 3).

[b]Cardiovascular diseases include high blood pressure, heart disease and stroke.

TABLE 2 BMI categories by dentition characteristics ($N = 1765$).

Characteristic	Total ($n = 1765$)	Underweight (<18.50 kg/m^2) ($n = 25$)	Normal (18.5–24.99 kg/m^2) ($n = 460$)	Overweight (25–29.99 kg/m^2) ($n = 717$)	Obese (≥30 kg/m^2) ($n = 563$)	*p* value
Number of remaining teeth[1]	20.0 (13.0–24.0)	17.0^{a,b} (11.5, 24.5)	20.0^{a} (14.0, 24.0)	20.0^{a} (14.0, 24.0)	19.0^{b} (11.0, 23.0)	.001
Number of anterior occluding pairs of teeth[1]	5.0 (2.0–6.0)	4.0 (1.0, 5.0)	5.0 (2.0, 6.0)	5.0 (2.0, 6.0)	5.0 (1.0, 6.0)	.108
Number of posterior occluding pairs of teeth[1]	2.0 (0.0–5.0)	2.0^{a,b} (0.0, 4.5)	3.0^{a} (0.0, 5.0)	2.0^{a} (0.0, 5.0)	2.0^{b} (0.0, 4.0)	<.001
Presence of functional dentition						
No (0–20 teeth)	973 (55.1)	16 (64.0)	233 (50.7)	381 (53.1)	343 (60.9)	.004
Yes (21–28 teeth)	792 (44.9)	9 (36.0)	227 (49.3)	336 (46.9)	220 (39.1)	
Number of remaining teeth						
0 Teeth (completely edentulous)	95 (5.4)	2 (8.0)	24 (5.2)	33 (4.6)	36 (6.4)	.263
1–27 teeth (partially dentate)	1581 (89.6)	23 (92.0)	408 (88.7)	643 (89.7)	507 (90.1)	
28 teeth (completely dentate)	89 (5.0)	0 (0)	28 (6.1)	41 (5.7)	20 (3.6)	
Number of anterior occluding pairs of teeth						
0–3	587 (33.3)	12 (48.0)	151 (32.8)	226 (31.5)	198 (35.2)	.223
4–6	1178 (66.7)	13 (52.0)	309 (67.2)	491 (68.5)	365 (64.8)	
Number of posterior occluding pairs of teeth						
0–4	1276 (72.3)	19 (76.0)	314 (68.3)	504 (70.3)	439 (78.0)	.002
5–8	489 (27.7)	6 (24.0)	146 (31.7)	213 (29.7)	124 (22.0)	
Types of dentures[2]						
No maxillary and partial mandibular	181 (29.9)	1 (14.3)	45 (33.1)	66 (26.1)	69 (32.9)	.357
Partial maxillary and partial mandibular	172 (28.4)	2 (28.6)	30 (22.1)	76 (30.0)	64 (30.5)	
Partial maxillary and no mandibular	155 (25.6)	1 (14.3)	36 (26.5)	73 (28.9)	45 (21.4)	
Full maxillary and full mandibular	87 (14.4)	3 (42.9)	20 (14.7)	34 (13.4)	30 (14.3)	
Partial maxillary and full mandibular	9 (1.5)	0 (0)	4 (2.9)	3 (1.2)	2 (1.0)	
No Maxillary and full mandibular	2 (0.3)	0 (0)	1 (0.7)	1 (0.7)	0 (0)	

Abbreviation: BMI, body mass index.

Note: Values are frequencies (%). Percentages may not add up to 100% due to rounding. *p* values are based on the Kruskal–Wallis test for the continuous variables and chi-square or Fisher's exact test for categorical variables. [a,b]Labelled medians without a common superscript letter indicate significant differences between groups in each row after adjustment for multiple comparisons by the Bonferroni correction ($p < .05$).

[1]Values are median (quartile 1–quartile 3).

[2]$n = 606$.

TABLE 3 Odds ratios and 95% confidence intervals for dentition and weight status measures.[a]

Dentition status	Unadjusted OR (95% CI) ($n = 1765$)	p	Adjusted OR (95% CI) ($n = 1727$)	p
Total number of remaining teeth				
Underweight (<18.50 kg/m^2)	0.974 (0.927, 1.024)	.300	0.976 (0.926, 1.028)	.357
Normal (18.5–24.99 kg/m^2)	1.00 (reference)	–	1.00 (reference)	
Overweight (25–29.99 kg/m^2)	1.00 (0.984, 1.015)	.970	1.003 (0.987, 1.019)	.711
Obese (≥ 30 kg/m^2)	0.976 (0.961, 0.992)	**.003**	0.980 (0.964, 0.997)	**.022**
Total number of anterior occluding pairs of teeth				
Underweight (<18.50 kg/m^2)	0.894 (0.762, 1.048)	.167	0.913 (0.772, 1.080)	.290
Normal (18.5–24.99 kg/m^2)	1.00 (reference)	–	1.00 (reference)	–
Overweight (25–29.99 kg/m^2)	0.994 (0.946, 1.045)	.811	1.005 (0.954, 1.058)	.864
Obese (≥ 30 kg/m^2)	0.954 (0.906, 1.004)	.071	0.967 (0.916, 1.021)	.230
Total number of posterior occluding pairs of teeth				
Underweight (<18.50 kg/m^2)	0.946 (0.806, 1.110)	.493	0.948 (0.803, 1.118)	.525
Normal (18.5–24.99 kg/m^2)	1.00 (reference)	–	1.00 (reference)	–
Overweight (25–29.99 kg/m^2)	1.005 (0.961, 1.051)	.828	1.011 (0.966, 1.059)	.632
Obese (≥ 30 kg/m^2)	0.920 (0.876, 0.965)	**<.001**	0.931 (0.885, 0.980)	**.006**
Functional dentition[b]				
Underweight (<18.50 kg/m^2)	1.732 (0.750, 3.999)	.198	1.726 (0.729, 4.090)	.215
Normal (18.5–24.99 kg/m^2)	1.00 (reference)	–	1.00 (reference)	–
Overweight (25–29.99 kg/m^2)	1.105 (0.874, 1.396)	.405	1.077 (0.846, 1.371)	.548
Obese (≥30 kg/m^2)	1.519 (1.184, 1.949)	**.001**	1.400 (1.078, 1.818)	**.012**

Abbreviations: CI, confidence intervals; OR, odds ratio.

[a]ORs, 95% CIs, and two-sided p-values are derived from univariable logistic regression for unadjusted models and multivariable logistic regression adjusted for age, gender, presence of gastrointestinal disorders, cardiovascular diseases and diabetes.

[b]Reference group is those with functional dentition.

Values in bold indicate $p < .05$.

pairs of teeth, (3) the number of posterior occluding pairs of teeth and (4) having a functional dentition. The only hypothesis that was accepted supported no association between BMI and the number of anterior occluding pairs of teeth. The other three hypotheses were rejected; those with fewer teeth, fewer posterior occluding pairs of teeth and those who lacked a functional dentition had higher odds of being obese than those with more remaining teeth, more posterior occluding pairs of teeth and those with a functional dentition.

The strengths of this study include its large sample size, and that we used multinomial logistic regression models to determine the associations between dentition status and weight status, adjusting for clinically and statistically relevant covariates. As data were originally collected as part of routine patient care, limitations include missing data for some of the demographic characteristics. Since data for race and ethnicity were missing for more than 50% of the sample, we excluded these variables from the multivariable regression models. Including self-reported data is another limitation, as is the unavailability of data on additional variables that may affect weight status such as dietary intake and physical activity patterns. Although one-third of the sample had partial or complete dentures, data on the use of dentures for eating was not obtained; hence, denture use was not included in the analyses.

Recently, the use of BMI as a measurement of weight status has been controversial, given that it does not directly assess body composition and heterogeneity exists across gender, racial, ethnic and age groups.[35,36] In July 2023, the American Medical Association (AMA) adopted a new policy on the use of BMI for diagnosing obesity and assessing the risk of weight-related disease.[36] It suggested that the BMI category alone should not be used as a predictor of morbidity and mortality and that healthcare professionals understand it's benefits and limitations in clinical practice.[35,36] We too, recognise these and have not used them to diagnose obesity in our sample, but rather to assess the weight status of our population for research purposes. Accordingly, the use of BMI without corresponding measurements of body composition, which were not available for analysis, was a limitation of this study.

Having a functional dentition has been defined and analysed in multiple ways in the dental literature.[37] While we have used the definition of 21 or more teeth, utilised by Dye et al. in their analysis of tooth loss in the U.S.,[3] we recognise that others have defined functional dentition as a shortened dental arch, 20 or more teeth or 10 or more functional tooth units.[25,38]

Findings from this study have limited generalisability. While our sample is representative of our clinic population, the data are from older adult patients who received care at a single urban northeastern U.S. dental school clinic. Despite being a racially and ethnically diverse sample, it is unlikely to be representative of the general U.S. population.[39] However, the findings add to the body of research in this area. The prevalence of overweight and obesity, which is higher in this study than others discussed, is consistent with the higher prevalence of overweight and obesity in the Americas than in other regions of the world.[40] While the aetiology of obesity is multifaceted, obesity is associated with a greater intake of high-calorie foods, especially those with added sugar and fermentable carbohydrates.[41] Sugars and fermentable carbohydrates fuel dental decay, which is a primary cause of tooth loss.[42,43] Thus, a diet high in sugar may contribute to both obesity and tooth loss. Future research should account for diet as a confounding factor associated with weight and dentition status, as well as the progressive nature and multifaceted aetiology of tooth loss and obesity.

Our findings revealed that a higher number of remaining teeth and posterior occluding pairs of teeth were associated with lower odds of obesity, while a lack of a functional dentition was associated with a higher likelihood of obesity. There have been a number of previous investigations of the associations between tooth loss and weight status.[5,25–29,44] Most of that work was done outside of the U.S., and there is considerable heterogeneity in methodological approaches, making the findings difficult to compare. However, similar to our findings, most investigators found that tooth loss was associated with non-normal weight status. A systematic review and meta-analysis exploring the relationship between obesity and tooth loss in adults, similarly found that adults with partial and complete tooth loss had 41% and 60% higher odds of obesity, respectively, and that age and the approach to tooth loss measurement explained 2.9% and 9.6% of the heterogeneity in the model.[44] Hilgert et al.[29] found that those who were edentulous and had maxillary dentures only were 2.3 times more likely to be obese than those with more than 8 teeth. Torres et al.[26] found that those who were edentulous and without dentures were 3.9 times more likely to be underweight and 2.9 times more likely to be overweight/obese than those with 20 or more teeth and dentures. Sheiham et al.[28] also found that those with fewer than 21 teeth were more than 3 times more likely to be obese than those with more teeth. Additionally, those who were edentulous were more likely to be underweight than those with 11 or more teeth (12.3% vs. 2.9%, respectively), as were those who had fewer than 10 teeth when compared with those with 11–32 teeth (24% vs. 2.9%). Perera et al.[27] similarly found that each missing tooth was associated with an 8% higher risk of being underweight, but not of being obese. Notably, 19.9% of their sample were underweight,[27] whereas, in the current study, only 1.4% were underweight, which may in part explain why we did not find similar associations between tooth loss and being underweight like many of these other studies found.

No associations between BMI and the number of anterior occluding pairs of teeth were found in our study. However, each additional number of posterior occluding pairs was associated with 7% lower odds of being obese. These findings are consistent with those of Sahyoun et al.[5] and Sheiham et al.[28] who found that obesity (or a higher BMI) was associated with having fewer posterior occluding pairs. Conversely, Perera et al.[27] found that those with more than 5 posterior occluding pairs had a significantly higher BMI than those with less than 5 posterior occluding pairs. However, only 17.8% of Perera's sample[27] were overweight and obese, whereas in this study sample, 72.5% were overweight or obese. Similar to the current study, 66.3% of Sheiham's sample[28] were overweight and obese and the mean BMI in Sahyoun et al.[6] was 27.4 kg/m^2, which is similar to this study sample (28.5 kg/m^2). Another aspect of oral dysfunction is the lack of a functional dentition. In this study, those who lacked a functional dentition had 1.4-fold higher odds of obesity. Although the proportion of underweight patients in the study was low (1.4%), those who were underweight were the most likely to lack a functional dentition, but these findings did not reach significance. Similar to our results, Sheiham et al.[28] found that those who lacked a functional dentition were 3 times more likely to be obese than those with a functional dentition. Conversely, Gaewkhiew et al[25] demonstrated that those with a functional dentition were 61% less likely to be underweight than those without a functional dentition, but no associations were identified between having a functional dentition and overweight/obesity. Loss of posterior occlusion and a functional dentition leads to masticatory difficulty, which negatively influences diet quality and nutrient consumption and can lead to changes in weight status.[6–17]

The differences between the findings from this study and earlier research may be due to different analytic approaches and sample characteristics. The current sample had the highest prevalence of older adults with overweight/obesity (72.6% vs. 17.8%–66.3%) and the lowest prevalence of older adults who were underweight (1.4% vs. 3.8%–19.9%) compared to earlier research in this area.[25–29] A higher prevalence of older adults in this study were at least partially dentate (94.6% vs. 23.7–55%) and had a higher prevalence of functional dentition than these earlier studies.[25–29] Despite these differences and consistent with other research, those with underweight and obesity had fewer teeth and posterior occluding pairs than those with normal weight status and were more likely to lack a functional dentition.[6,25–29] Oral dysfunction, especially the loss of posterior occlusion and a functional dentition negatively impacts biting, chewing and swallowing, which subsequently influences diet quality and nutrient consumption. This can lead to changes in weight status, depending on the number and extent of the patient's adaptive and maladaptive eating behaviours.[6–17] Food avoidance may result in unintentional weight loss, while replacement of harder-to-chew, nutrient-dense foods with easier-to-chew, more calorically dense foods may result in weight gain. These changes in diet can lead to an increased risk of obesity and malnutrition, with and without sarcopenia.[18–20,22]

4.1 | Implications for practice and future research

These findings support the need for interprofessional practice integrating primary care with nutrition and oral health care.[45] Malnutrition, underweight and obesity, with and without sarcopenia, are major public health concerns in older adults.[20,21,23] Dentists, registered dietitian nutritionists (RDNs), primary care providers and other community healthcare professionals can routinely assess dentition status, screen patients for non-normal BMI and assess dietary intake as it relates to the condition of the oral cavity. Questions about difficulties with biting, chewing and swallowing to identify barriers to the adequacy of oral intake are critical. As oral health and nutrition concerns arise, healthcare providers can collaborate with dentists, RDNs and other primary care providers and refer their patients as needed.[46] Interprofessional efforts can lead to measures to reduce the risk of obesity, malnutrition and oral dysfunction across healthcare settings.[45,46] Further research is needed with culturally diverse samples that are adequately powered and adjusted for potential confounding variables including comorbid conditions, economic status, oral function, dietary intake, sarcopenia and physical activity. Findings can be used to develop interventions to reduce risks of underweight, obesity, malnutrition and oral dysfunction in this population.

5 | CONCLUSIONS

The findings of this study demonstrated that older adults with obesity who received care at an urban northeast U.S. dental school clinic were significantly more likely to have fewer teeth, fewer posterior occluding pairs of teeth and lack a functional dentition than those of normal weight. A similar pattern was seen whereby those who were underweight had the fewest teeth, the fewest anterior and posterior occluding pairs of teeth and were most likely to lack a functional dentition.

AUTHOR CONTRIBUTIONS

All authors were involved in concept and design, data analysis and interpretation of data. HS was the lead statistician in this study. As the primary investigator and first author, RZ drafted the article along with AL, but all co-authors have provided critical feedback and have approved the final version, which is being submitted.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the Rutgers School of Dental Medicine Offices of Clinical Affairs and Information Technology.

FUNDING INFORMATION

No funding was provided for this study.

CONFLICT OF INTEREST STATEMENT

All authors declare that they have no conflicts of interest.

DATA AVAILABILITY STATEMENT

The datasets used and/or analysed during the current study can be made available from the corresponding author upon reasonable request if approved by the IRB.

ETHICS STATEMENT

This study was approved by the Rutgers University Institutional Review Board (Pro2021000687). A waiver of consent was granted as the study was a secondary analysis of patient data routinely collected at our institution. Results were analysed and reported in aggregate without patient identifiers. As such the risk of harm was minimal and the rights and welfare of the subjects were not adversely affected.

KNOWLEDGE TRANSFER STATEMENT

The findings from this study suggest that among older adults, tooth loss, especially the loss of posterior occlusion and lack of a functional dentition, are associated with obesity. Healthcare professionals should include screening for impaired dentition and weight status as part of their routine practice to identify at-risk patients and refer them for interventions to optimise oral health, nutrition and overall health status.

ORCID

Rena Zelig https://orcid.org/0000-0003-0003-1205

REFERENCES

1. Centers for Disease Control and Prevention. Oral Health Surveillance Report: Trends in Dental Caries and Sealants, Tooth Retention, and Edentulism, United States, 1999–2004 to 2011–2016. https://www.cdc.gov/oralhealth/publications/OHSR-2019-index.html. Accessed November 13, 2023.
2. National Institutes of Health. *Oral Health in America: Advances and Challenges*. US Department of Health and Human Services, National Institutes of Health, National Institute of Dental and Craniofacial Research; 2021. https://www.nidcr.nih.gov/sites/default/files/2021-12/Oral-Health-in-America-Advances-and-Challenges.pdf. Accessed November 13, 2023.

3. Dye BA, Weatherspoon DJ, Lopez MG. Tooth loss among older adults according to poverty status in the United States from 1999 through 2004 and 2009 through 2014. *J Am Dent Assoc*. 2019;150(1):9-23. doi:10.1016/j.adaj.2018.09.010
4. Petersen PE, Kandelman D, Arpin S, Ogawa H. Global oral health of older people–call for public health action. *Community Dent Health*. 2010;27(4 Suppl 2):257-267.
5. Thomson WM. The life course and oral health in old age. *J R Soc N Z*. 2023;54:1-10. doi:10.1080/03036758.2023.2203933
6. Sahyoun NR, Lin CL, Krall E. Nutritional status of the older adult is associated with dentition status. *J Am Diet Assoc*. 2003;103(1):61-66. doi:10.1053/jada.2003.50003
7. Zhu Y, Hollis JH. Tooth loss and its association with dietary intake and diet quality in American adults. *J Dent*. 2014;42(11):1428-1435. doi:10.1016/j.jdent.2014.08.012
8. Yoshihara A, Watanabe R, Nishimuta M, Hanada N, Miyazaki H. The relationship between dietary intake and the number of teeth in elderly Japanese subjects. *Gerodontology*. 2005;22(4):211-218. doi:10.1111/j.1741-2358.2005.00083.x
9. Iwasaki M, Taylor GW, Manz MC, et al. Oral health status: relationship to nutrient and food intake among 80-year-old Japanese adults. *Community Dent Oral Epidemiol*. 2014;42(5):441-450. doi:10.1111/cdoe.12100
10. Kiesswetter E, Poggiogalle E, Migliaccio S, et al. Functional determinants of dietary intake in community-dwelling older adults: a DEDIPAC (DEterminants of DIet and physical ACtivity) systematic literature review. *Public Health Nutr*. 2018;21(10):1886-1903. doi:10.1017/S1368980017004244
11. Lee JS, Weyant RJ, Corby P, et al. Edentulism and nutritional status in a biracial sample of well-functioning, community-dwelling elderly: the health, ageing, and body composition study. *Am J Clin Nutr*. 2004;79(2):295-302. doi:10.1093/ajcn/79.2.295
12. Zelig R, Jones VM, Touger-Decker R, et al. The eating experience: adaptive and maladaptive strategies of older adults with tooth loss. *JDR Clin Trans Res*. 2019;4(3):217-228. doi:10.1177/2380084419827532
13. Zelig R, Touger-Decker R, Chung M, Byham-Gray L. Associations between tooth loss, with or without dental prostheses, and malnutrition risk in older adults: a systematic review. *Top Clin Nutr*. 2016;31(3):232-247. doi:10.1097/TIN.0000000000000077
14. Ritchie CS, Joshipura K, Silliman RA, Miller B, Douglas CW. Oral health problems and significant weight loss among community-dwelling older adults. *J Gerontol A Biol Sci Med Sci*. 2000;55(7):M366-M371. doi:10.1093/gerona/55.7.M366
15. Zelig R, Goldstein S, Touger-Decker R, et al. Tooth loss and nutritional status in older adults: a systematic review and meta-analysis. *JDR Clin Trans Res*. 2022;7(1):4-15. doi:10.1177/2380084420981016
16. Yoshida M, Kikutani T, Yoshikawa M, Tsuga K, Kimura M, Akagawa Y. Correlation between dental and nutritional status in community-dwelling elderly Japanese. *Geriatr Gerontol Int*. 2011;11(3):315-319. doi:10.1111/j.1447-0594.2010.00688.x
17. Shiota C, Kusama T, Takeuchi K, Kiuchi S, Osaka K. Oral hypofunction and risk of weight change among independent older adults. *Nutrients*. 2023;15(20):4370. doi:10.3390/nu15204370
18. Honeywell S, Samavat H, Touger-Decker R, Parrott JS, Hoskin E, Zelig R. Associations between dentition status and nutritional status in community-dwelling older adults. *JDR Clin Trans Res*. 2023;8(1):93-101. doi:10.1177/23800844211063859
19. Hussein S, Kantawalla RF, Dickie S, Suarez-Durall P, Enciso R, Mulligan R. Association of oral health and mini nutritional assessment in older adults: A systematic review with meta-analyses. *J Prosthodont Res*. 2022;66:208-220. doi:10.2186/jpr.JPR_D_20_00207
20. Dent E, Wright ORL, Woo J, Hoogendijk EO. Malnutrition in older adults. *Lancet*. 2023;401(10380):951-966. doi:10.1016/S0140-6736(22)02612-5
21. World Health Organization. Malnutrition. https://www.who.int/health-topics/malnutrition#tab=tab_1. Accessed November 13, 2023.
22. Moynihan PJ, Teo JL. Exploring oral function, protein intake, and risk of sarcopenia: a scoping review. *JDR Clin Trans Res* 2023;9:20. doi:10.1177/23800844231157259
23. Donini LM, Busetto L, Bischoff SC, et al. Definition and diagnostic criteria for sarcopenic obesity: ESPEN and EASO consensus statement. *Clin Nutr*. 2022;41(4):990-1000. doi:10.1016/j.clnu.2021.11.014
24. Azzolino D, Passarelli PC, De Angelis P, Piccirillo GB, D'Addona A, Cesari M. Poor oral health as a determinant of malnutrition and sarcopenia. *Nutrients*. 2019;11(12):2898. doi:10.3390/nu11122898
25. Gaewkhiew P, Sabbah W, Bernabé E. Functional dentition, dietary intake and nutritional status in Thai older adults. *Gerodontology*. 2019;36(3):276-284. doi:10.1111/ger.12408
26. Tôrres LH, da Silva DD, Neri AL, Hilgert JB, Hugo FN, Sousa ML. Association between underweight and overweight/obesity with oral health among independently living Brazilian elderly. *Nutrition*. 2013;29(1):152-157. doi:10.1016/j.nut.2012.05.011
27. Perera R, Ekanayake L. Relationship between nutritional status and tooth loss in an older population from Sri Lanka. *Gerodontology*. 2012;29(2):e566-e570. doi:10.1111/j.1741-2358.2011.00518.x
28. Sheiham A, Steele JG, Marcenes W, Finch S, Walls AW. The relationship between oral health status and body mass index among older people: a national survey of older people in Great Britain. *Br Dent J*. 2002;192(12):703-706. doi:10.1038/sj.bdj.4801461
29. Hilgert JB, Hugo FN, de Sousa ML, Bozzetti MC. Oral status and its association with obesity in southern Brazilian older people. *Gerodontology*. 2009;26(1):46-52. doi:10.1111/j.1741-2358.2008.00226.x
30. Axium. https://www.exansoftware.com/. Accessed November 13, 2023.
31. Rutgers School of Dental Medicine. https://sdm.rutgers.edu/. Accessed November 13, 2023.
32. Centers for Disease Control and Prevention. Body Mass Index (BMI). https://www.cdc.gov/healthyweight/assessing/bmi/index.html. Accessed November 13, 2023.
33. Centers for Disease Control and Prevention. National Center for Chronic Disease Prevention and Health Promotion, Division of Nutrition, Physical Activity, and Obesity. Data, Trend and Maps. 2023. https://www.cdc.gov/nccdphp/dnpao/data-trends-maps/index.html. Accessed November 13, 2023.
34. Centers for Disease Control and Prevention. Defining Adult Overweight and Obesity. 2022. https://www.cdc.gov/obesity/basics/adult-defining.html. Accessed JNovember 13, 2023.
35. American Medical Association House of Delegates Handbook. Report 07 of the Council on Science and Public Health. *Support Removal of BMI as a Standard Measure in Medicine and Recognizing Culturally-Diverse and Varied Presentations of Eating Disorders and Indications for Metabolic and Bariatric Surgery*. Resolution 407-A-22, 65-83 2023. https://www.ama-assn.org/system/files/a23-handbook-refcom-d.pdf#page=65. Accessed November 13, 2023.
36. American Medical Association. Press Release: AMA adopts new policy clarifying the role of BMI as a measure in medicine. 2023. https://www.ama-assn.org/press-center/press-releases/ama-adopts-new-policy-clarifying-role-bmi-measure-medicine. Accessed November 13, 2023.
37. Glick M. The relevance of oral health. *J Am Dent Assoc*. 2019;150(8):637-638. doi:10.1016/j.adaj.2019.06.019
38. Gotfredsen K, Walls AW. What dentition assures oral function? *Clin Oral Implants Res*. 2007;18(Suppl 3):34-45. doi:10.1111/j.1600-0501.2007.01436.x
39. U.S. Census Bureau Quick Facts: United States. https://www.census.gov/quickfacts/fact/table/US/PST045221. Accessed November 13, 2023.

40. Boutari C, Mantzoros CS. A 2022 update on the epidemiology of obesity and a call to action: as its twin COVID-19 pandemic appears to be receding, the obesity and dysmetabolism pandemic continues to rage on. *Metabolism*. 2022;133:155217. doi:10.1016/j.metabol.2022.155217
41. U.S. Department of Health and Human Services and U.S. Department of Agriculture. 2020–2025 Dietary Guidelines for Americans, 9th edition. https://www.dietaryguidelines.gov/sites/default/files/2020-12/Dietary_Guidelines_for_Americans_2020-2025.pdf. Accessed November 13, 2023.
42. Marshall T. Dietary implications for dental caries: a practical approach on dietary counseling. *Dent Clin N Am*. 2019;63(4):595-605. doi:10.1016/j.cden.2019.06.005
43. Moores CJ, Kelly SAM, Moynihan PJ. Systematic review of the effect on caries of sugars intake: ten-year update. *J Dent Res*. 2022;101(9):1034-1045. doi:10.1177/00220345221082918
44. Nascimento GG, Leite FR, Conceicao DA, Ferrua CP, Singh A, Demarco FF. Is there a relationship between obesity and tooth loss and edentulism? A systematic review and meta-analysis. *Obes Rev*. 2016;17(7):587-598. doi:10.1111/obr.12418
45. Weintraub JA, Kaeberlein M, Perissinotto C, et al. Geroscience: aging and oral health research. *Adv Dent Res*. 2023;31(1):2-15. doi:10.1177/08959374231200840
46. Nelson S, Kim EGR, Kaelber DC. Integrating oral health into primary care: perspectives for older adults. *J Dent Res*. 2023;102(8):849-853. doi:10.1177/00220345231165011

How to cite this article: Zelig R, Lyon A, Touger-Decker R, Singer SR, Samavat H. Dentition and weight status in community-dwelling older adults. *Gerodontology*. 2024;41:516-525. doi:10.1111/ger.12747