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Self-rated Oral Health and Frailty Index Among Older Americans.

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Abstract:**Objective:**

To assess the association between self-rated oral health and frailty index among older American adults aged 60 years and over.

Materials and methods:

Data from the National Health and Nutrition and Examination Survey from 2011 to 2014 was used. Self-rated oral health was assessed based on a single question “rate the health of your teeth and gum”. A frailty index of 49-items covering multiple systems was created. Age, gender, ethnicity, poverty-income ratio, education, poor nutritional intake and smoking were used as covariates. Weighted negative binomial regression was used to test the association between self-rated oral health and frailty index adjusting for the covariates.

Results:

A dose response relationship was observed between self-rated oral health and frailty index. The Rate Ratios (RR) of frailty index were 1.03 (95% CI 0.95 – 1.13), 1.15 (95% CI 1.05 – 1.25), 1.30 (95% CI 1.17 – 1.45), 1.41(95% CI 1.28 – 1.54) for participants who rated their oral health very good, good, fair, or poor, respectively, compared with those who rated their oral health excellent after adjusting for covariates.

Conclusion:

Poorer self-rated oral health is associated with higher rates of frailty index. This highlights the importance of oral health as a predictor of frailty and the adequacy of using self-rated oral health in health surveys and clinical practices when conducting a comprehensive clinical oral examination is not feasible.

Introduction:

Frailty is an important implication of ageing. Frailty is a state characterized by higher vulnerability to adverse health outcomes for older adults.¹ Frailty is prevalent among community-dwelling older adults and the ageing populations.² The evidence indicates that frailty is associated with mortality, chronic diseases, depression, dependence, and reduced quality of life.³ The underlying mechanism of frailty is related to impairments to the neuro-immuno-endocrine system, physical activity, and nutritional status, that modulate the process of ageing.⁴ The most two prevailing models of frailty are the phenotypic model which define frailty based on the presence of three of five physical criteria,⁵ and the multiple deficit model which rates frailty based on the number of deficits across multiple domains.⁶

Oral health is associated with nutritional status and nutritional intake among older adults.^{7,8} Furthermore, the evidence indicates that oral health could be one of the predictors and markers of frailty.⁹ Most of the previous studies that assessed the relationship between oral health and frailty used clinical and objective measure like, number of teeth, periodontal disease and oral function indicators.⁹ Which might not always be feasible to be collected in several settings and entails high cost. Most of the earlier studies also focused on the phenotypic model of frailty.

Many epidemiological surveys of population-based samples of older adults collect information on self-rated oral health along clinical data. Self-rated oral health reflects the functional, psychological and social impact of oral conditions on the overall wellbeing.¹⁰ The single item self-rated oral health indicator is a valid, reliable and cost-effective tool for assessing oral health and has been tested among different cultures and community-dwelling older adults and institutionalized older adults.¹¹⁻¹³

With the increased interest of studying and understanding important ageing outcomes, such as frailty, including oral health examination might not always be feasible due to the cost or the lack of resources and personnel. Furthermore, comprehensive geriatric assessments do not include oral health measures.¹⁴ Therefore, it is important to investigate the association between self-rated oral health and frailty index using a national representative sample to validate and promote its use in future epidemiological research related to frailty among older adults. This study aimed to assess the association between self-rated oral health and frailty index among a nationally representative sample of older American adults.

Methods:

We analysed data from the National Health and Nutrition Examination Survey (NHANES) from 2011 to 2014 (two 2-year survey periods: 2011-2012 and 2013-2014). NHANES is a cross-sectional survey that assesses the health and nutrition of civilian non-institutionalized Americans. NHANES selects participants through a complex multistage probability design, we used survey weight to adjust for the estimate throughout the analysis. The analysis was limited to participants aged ≥ 60 years with full mouth examination. Of the 19,931 participants with interview data, 3,630 were identified as being 60 years or older. From this group, participants who did not have complete oral health examination or had missing data in any other covariate were excluded to yield a final analytical sample size of 2,368 older adults.

Frailty index:

Frailty was the outcome variable of this study. A 49-item frailty index was created following the standard procedure for constructing the frailty index.¹⁵ The frailty index included deficits that covered multiple systems including chronic diseases, activities of daily living, depressive

symptoms, cognition, anthropometric measures and physical performance, general health status and health care utilization, and lab values. The deficits included for each system and their cut-off points are presented in Supplementary file 1. The number of acquired deficits by each participant was divided by the number of all considered deficits to produce the frailty index score which ranges from 0 to 1. A cut-off point of 0.21 was used to indicate frailty in the descriptive analysis.¹⁶

Self-rated oral health:

In NHANES, self-rated oral health was assessed based on a single question “rate the health of your teeth and gum”. The answers were: Excellent, very good, good, fair, and poor.

Covariates:

Age, gender, race, education, poverty-income ratio, smoking, and poor nutritional intake were used as covariates in this study. Race was grouped into Mexican American, other Hispanic, non-Hispanic White, non-Hispanic Black, and other races. Education had three categories that included less than 12 years of education, 12 years of education or more than 12 years of education. Smoking groups were never smokers, previous smoker, and current smokers. The ratio of family income to poverty reflects family income relative to the poverty threshold and it was used as a continuous variable. Poor nutritional intake variable was created based on the recommended dietary allowance of 13 micronutrients.¹⁷ A higher score for this variable indicates a poorer nutritional intake.

Statistical analysis:

We performed data analysis using Stata 16 (StataCorp, CollegeStation, TX, USA). We applied survey command throughout the analysis. Descriptive analysis was performed for the study variables stratified by frailty status. A score of 0.21 was used to define frailty.¹⁶ Negative binomial regression was also performed to assess the association between the five categories of self-rated oral health (excellent as a reference group) and frailty index adjusting for all the covariates (age, gender, race, education, ratio of family income to poverty, smoking, and poor nutritional intake).

Results:

Table 1 presents the weighted descriptive statistics for the study participants (n=2368). The mean age for the frail participants was almost three years higher (71 years; 95% CI: 70.3 – 71.6 years) than non-frail (67.9 years; 95% CI: 67.4 – 68.4 years). Fifty-two per cent of the study participants were female, 60.2% had more than 12 years of education, and 72.9% were non-Hispanic White. Mean poverty-income ratio was lower among frail participants (2.4; 95% CI: 2.34 – 2.6) than non-frail (3.4; 95% CI: 3.2 – 3.5), poor nutritional intake was higher among frail participants (8.5; 95% CI: 7.3 – 8.6) than non-frail (7.9; 95% CI: 7.6 – 8.2). In terms of self-rated oral health, 34.8% of participants rated their oral health as good. The frail group had a higher percentage of poor self-ratings of oral health (12.1%; 95% CI: 9.6 – 15.1) compared to the non-frail group (4.8 %; 95% CI: 3.6 – 6.3). Furthermore, the frail group had a lower percentage of excellent self-ratings of oral health (10.9%; 95% CI: 8.3 – 14.2) compared to the non-frail group (18.7%; 95% CI: 15.6 – 22.3).

The weighted negative binomial regression rate ratios for frailty index are presented in Table 2. For each additional year, the rate ratio (RR) for frailty increased to 1.01 (95% CI 1.01- 1.02). Females had a RR of 1.14 (95% CI 1.06 – 1.22) compared to males. Participants with more

than 12 years of education had a decreased RR of frailty 0.87 (95% CI 0.83 – 0.92) compared to participants with less than 12 years of education. The RR of frailty for poverty-income ratio and poor nutritional intake was 0.93 (95% CI 0.91 – 0.95) and 1.01 (95% CI 1.00 – 1.02), respectively. In terms of self-rated oral health, a dose response association was observed as worse self-rated oral health had higher rates of frailty index. The RR of frailty index were 1.03 (95% CI 0.95 – 1.13), 1.15 (95% CI 1.05 – 1.25), 1.30 (95% CI 1.17 – 1.45), 1.41(95% CI 1.28 – 1.54) for participants who rated their oral health as very good, good, fair, or poor, respectively, compared with those who rated their oral health as excellent.

Discussion:

The results of this study indicate that among a nationally representative sample of older adults self-rated oral health is associated with frailty index. In particular, a dose responses relationship between self-rated oral health and frailty was observed, the worse the self-rating of oral health, the higher the rate of frailty index score.

Self-rated oral health was found to be associated with frailty phenotype in previous cross-sectional studies.¹⁸⁻²⁰ Ramsay and colleagues found that self-rated oral health was associated with 3-year frailty phenotype incidence among older British men after adjusting for age. However, this association was not significant in the fully adjusted model.¹⁹ To our knowledge, this is the first study to assess the association between self-rated oral health and frailty index among older adults using a national representative sample. Previous studies that assessed the association between oral health and frailty index used a self-reported number of teeth,²¹ and the count of self-reported oral health problems.²² Both studies found significant associations with frailty index.

The most plausible mechanism that links oral health and frailty is the nutritional pathway, as oral health has a great impact on food selection, nutritional intake and ultimately nutritional status⁹. Previous reports found that poor diet (based on the consumption of essential food groups),²² and inadequate nutritional intake (based on micronutrient intake),²³ have modest mediating effects on the association between oral health and frailty index. In a previous report, we demonstrated that clinical indicators of oral health namely, number of teeth, and to a lesser degree, periodontal disease are associated with frailty index among older Americans after adjusting for inadequate nutritional intake and important covariates similar to the results observed with self-rated oral health in this study.²³ This can be explained as self-rated oral health is associated with clinical measures of oral health,¹¹ and predict five-years and ten-years tooth loss.²⁴ therefore, self-rated oral health reflects to some extent the previously evaluated associations between clinical oral health indicators and frailty.²⁵ The psychosocial impact of poor oral health on loneliness, socialization,²⁶ self-consciousness and embarrassment,²⁷ and depressive symptoms among older adults,^{28,29} should also be considered as a possible link for the observed association in this study. Self-rated oral health reflects the psychological and social impact of oral conditions on the overall wellbeing.¹⁰ Previous evidence indicates that depression,^{30,31} loneliness are associated with frailty.³² A recent study has found that eating alone as social dietary behaviour is associated with oral frailty (a composite measure of dentition status, oral function indicators and subjective measure of oral health).³³ Furthermore, determinants of self-rated oral health could have some similarities with those of frailty index used here.

The results of this study are in line with the literature and indicate that oral health could be one of the markers and predictors of frailty. Frailty index as a multidomain tool for defining frailty could be constructed from routinely collected data from comprehensive geriatric assessments

(CGA).^{34,35} The CGAs concentrate on the whole person approach and evaluate multiple components of older adults' general health, which allows a comprehensive judgment on the overall health and the complex needs of older adults.³⁶ However, CGAs concentrate primarily on medical context and unfortunately, do not include oral health measures and components.¹⁴ Even though previous studies have demonstrated the benefits of integrating oral health screening with general health screening for older adults.³⁷⁻³⁹ This is might be hard to implement due to lack of dental staff and limited recourses. The single item self-rated oral health indicator is a valid, reliable and cost-effective tool for assessing oral health implication for research and can be used easily by non-dental providers. Currently, self-rated oral health is being commonly used in some national and community-based surveys in different countries.⁴⁰⁻⁴³ Nevertheless, it might be often overlooked by clinician and researchers based on the assumption that it is highly sensitive and not reliable compared clinically measured oral health. The results of this study imply the adequacy of using self-rated oral health in health surveys and clinical practices for older adults when a comprehensive oral assessment is not feasible.

Some limitations should be addressed. First, due to the nature of cross-sectional studies, the causal relationship between self-rated oral health and frailty cannot be implied. second, previous research found that self-rated oral health is highly sensitive and thus the results of this study might not apply to populations with different sociodemographic characteristics or different oral health status. Third, self-rated oral health and information related to some deficits included in the frailty index were gathered self-report and might make subjected to recall bias and social desirability bias. Nevertheless, to our knowledge, this is the first study to assess the association between self-rated oral health and frailty index that covers multiple systems including lab values and body performance measures. Longitudinal studies that assess the

association between self-rated oral health and frailty index are needed to enhance our understanding of this complex relationship and to confirm the results of this study.

Conclusion

Poorer self-rated oral health is associated with higher rates of frailty index. This highlights the importance of oral health as a predictor of frailty. This significant association also indicates the adequacy of using self-rated oral health in health surveys and clinical practices if conducting the comprehensive clinical oral examination is not feasible. The inclusion of self-rated oral health should be promoted for futures studies that assess frailty and other geriatric health outcomes.

Conflict of Interests:

The authors declare no conflict of interests.

Authors Contribution:

F Hakeem and W Sabbah conceived the research idea. F Hakeem conducted the analysis and wrote the first draft. E Bernabé and W Sabbah advised on data analysis and contributed to writing the manuscript. All authors take full responsibility for the paper.

Tables:

Table 1: Demographic, socioeconomic and oral health characteristics of American adults aged 60 years and over stratified by frailty status (percentage/means) NHANES 2011-14 (N=2,368)

	Non-frail	Frail	Total	P-value
	Percentage /mean			
<i>Mean Age</i>	67.9 (67.4 – 68.4)	71 (70.3 – 71.6)	69.1 (69.6 - 69.5)	0.0001
Gender				
<i>Male</i>	51.7 (49 – 54.4)	41.5 (37.4 – 45.7)	47.8 (45.4 – 50.2)	0.0002
<i>Female</i>	48.2 (45.5 – 50.0)	58.5 (54.3 – 62.5)	52.2 (49.7 – 54.6)	
Ethnicity				
<i><12 years</i>	12.2 (9.7 – 15.0)	25.7 (21.8 – 29.9)	17.4 (14.5 – 20.1)	0.0001
<i>=12 years</i>	20.1 (15.9 – 24.9)	25.8 (22.3 – 29.6)	22.3 (19.6 – 25.2)	
<i>>12 years</i>	67.7 (62.3 – 72.7)	48.4 (45.1 – 51.8)	60.2 (56.4 – 64.0)	
Ethnicity				
<i>Mexican American</i>	3.1 (1.8 – 5)	3.8 (2.2 – 6.4)	3.3 (2 – 5.4)	0.014
<i>Other Hispanic</i>	3.3 (2.2 – 4.8)	4.1 (2.5 – 6.4)	3.6 (2.4 – 5.2)	
<i>Non-Hispanic White</i>	80.5 (76.1 – 84.2)	77.0 (72.0 – 81.0)	79.2 (74.8 – 8)	
<i>Non-Hispanic black</i>	7.3 (5.2 -10.0)	10.0 (7.5 – 14.0)	8.5 (6.2 – 1)	
<i>Other</i>	5.7 (4.1 – 7.9)	4.6 (3.3 – 6.4)	5.3 (4 – 7.1)	
Smoking Groups				
<i>Never</i>	52.4 (48.7 – 56.1)	42.9 (38.7 – 47.2)	48.7 (45.6 – 51.9)	0.006
<i>Previous</i>	36.3 (32.9 – 39.8)	43.6 (39.6 – 47.8)	39.1 (36.3 – 42)	
<i>Current</i>	11.2 (9.1 – 13.7)	13.3 (10.6 – 16)	12 (10.5 – 13.6)	
<i>Mean poverty-income ratio</i>	3.4 (3.2 – 3.5)	2.4 (2.34 – 2.6)	3.0 (2.9 – 3.2)	0.0001
<i>Mean Poor nutritional intake</i>	7.9 (7.6 – 8.2)	8.5 (7.3 – 8.6)	8.1 (7.9 – 8.3)	0.002
Self-rated Oral health				
<i>Excellent</i>	18.7 (15.6 – 22.3)	10.9 (8.3 – 14.2)	15.7 (13.6 – 18.0)	0.0001
<i>Very good</i>	29.9 (25.5 – 34.6)	21.9 (19.1 – 25.0)	26.8 (23.6 – 30.2)	
<i>Good</i>	34.6 (31.8 – 37.5)	35.2 (31.2 – 39.5)	34.8 (32.2 – 37.5)	
<i>Fair</i>	11.9 (10.0 – 13.9)	19.7 (16.2 – 23.6)	14.9 (13.2 – 16.8)	
<i>Poor</i>	4.8 (3.6 – 6.3)	12.1 (9.6 – 15.1)	7.6 (6.2 – 9.2)	

Table 2: Negative binomial regression model showing the associations between self-rated oral health and frailty index among *American adults aged 60 years and over*, NHANES 2011-14 (N= 2,368)

		Fully adjusted model	
		RR	p-value
Age		1.02 (1.01- 1.02)	<0.001
Gender	Male	(Reference)	
	Female	1.14 (1.06 – 1.22)	<0.001
Self-rated oral health	<i>Excellent</i>	(References)	
	<i>Very good</i>	1.03 (0.95 – 1.13)	0.383
	<i>Good</i>	1.15 (1.05 – 1.25)	0.002
	<i>Fair</i>	1.30 (1.17 – 1.45)	<0.001
	<i>Poor</i>	1.41 (1.28 – 1.54)	<0.001
Poor nutritional intake		1.01 (1.00 – 1.02)	0.006
Education	Less than 12 years	(Reference)	
	12 Years	0.93 (0.85 – 1.02)	0.141
	More than 12 years	0.87 (0.83 – 0.92)	<0.001
Ethnicity	Mexican American	(Reference)	
	Other Hispanic	0.95 (0.87 – 1.04)	0.329
	Non- Hispanic White	1.01 (0.94 – 1.09)	0.623
	Non- Hispanic Black	1.04 (0.95 – 1.14)	0.33
	Other	0.96 (0.83 – 1.11)	0.631
Poverty-income ratio		0.93 (0.91 – 0.95)	<0.001
Smoking	Never	(Reference)	
	Former	1.10 (1.03 – 1.17)	0.002
	current	1.08 (0.95 – 1.22)	0.48

RR: Rate ratio

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