Received: 5 April 2023 | Revised: 10 May 2023 | Accepted: 11 May 2023

DOI: 10.1111/jgs.18423

CLINICAL INVESTIGATION

Journal of the American Geriatrics Society

Social participation and tooth loss, vision, and hearing impairments among older Brazilian adults

Eduardo Bernabé PhD[1] | **Cesar de Oliveira PhD**[2] | **Yeda Aparecida de Oliveira Duarte PhD**[3] | **Fabiola Bof de Andrade PhD**[4] | **Wael Sabbah PhD**[5]

[1]Institute of Dentistry, Queen Mary University of London, London, UK

[2]Department of Epidemiology & Public Health, University College London, London, UK

[3]School of Public Health, University of São Paulo, Brazil

[4]Rene Rachou Institute, Oswaldo Cruz Foundation, Belo Horizonte, Brazil

[5]Faculty of Dentistry, Oral & Craniofacial Sciences, King's College London, London, UK

Correspondence
Eduardo Bernabé, Institute of Dentistry, Queen Mary University of London, Royal London Dental Hospital, Turner Street, London E1 2AD, UK.
Email: e.bernabe@qmul.ac.uk

Abstract

Background: Vision and hearing impairments can reduce participation in social activities. Given the prominent role of the mouth in face-to-face interactions, this study evaluated the associations of tooth loss, vision, and hearing impairments with social participation among older adults.

Methods: This analysis included 1947 participants, aged 60+ years, who participated in three waves (2006, 2010, and 2015) of the Health, Wellbeing and Aging Study (SABE) in Brazil. Social participation was measured by the number of formal and informal social activities (requiring face-to-face interaction) participants were regularly involved in. Teeth were counted during clinical examinations and categorized as 0, 1–19, and 20+ teeth. Reports on vision and hearing impairments were classified into three categories (good, regular, and poor). The associations of each impairment with the 9-year change in the social participation score were tested in negative binomial mixed-effects models adjusting for time-variant and time-invariant covariates.

Results: Each impairment was associated with the baseline social participation score and the annual rate of change in the social participation score. Participants with 1–19 (incidence rate ratio: 0.96, 95% CI: 0.91–1.01) and no teeth (0.92, 95% CI: 0.87–0.97), those with regular (0.98, 95% CI: 0.95–1.01) and poor vision (0.86, 95% CI: 0.81–0.90), and those with regular (0.94, 95% CI: 0.91–0.98) and poor hearing (0.91, 95% CI: 0.87–0.95) had lower baseline social participation scores than those with 20+ teeth, good vision, and good hearing, respectively. Furthermore, participants with 1–19 (0.996, 95% CI: 0.990–1.002) and no teeth (0.994, 95% CI: 0.987–0.999), those with regular (0.996, 95% CI: 0.992–0.999) and poor vision (0.997, 95% CI: 0.991–1.003), and those with regular (0.997, 95% CI: 0.992–1.001) and poor hearing (0.995, 95% CI: 0.990–0.999) had greater annual declines in the social participation score than those with 20+ teeth, good vision and good hearing, respectively.

Conclusion: This 9-year longitudinal study shows that tooth loss, vision, and hearing impairments are associated with reduced social participation among older adults.

KEYWORDS

aged, cohort studies, hearing loss, social participation, tooth loss, vision disorders

INTRODUCTION

Social participation is a strong measure of successful aging,[1] which is associated with a higher quality of life, better cognition and lower risk of mortality.[2,3] Older adults are at greater risk of experiencing a reduction in social participation due to changes in their physical and mental health (chronic conditions, depression, cognitive decline, and functional limitations), their roles (reduced social networks and support) and their local environment (accessibility, transport, and neighborhood cohesion).[4,5]

Globally, 57.9% and 33.5% of older adults suffer from hearing and vision loss, respectively.[6,7] Hearing and vision impairments compromise an individual's capacity to extract information from the environment and create barriers to communication.[8] They reduce the ability to perform activities of daily living, jeopardizing independence and well-being, and increasing the risk of social isolation.[9,10] Tooth loss is another common impairment, affecting 19.2% of older adults globally.[11] Besides its intrinsic function, the mouth plays a crucial role in face-to-face social interaction. Older adults with severe tooth loss are more likely to feel embarrassed,[12,13] avoid smiling, talking, and eating in public,[14,15] and become homebound,[16] which can reduce opportunities for social interactions. Although vision, hearing and tooth loss often occur together in older populations, they are commonly viewed separately in research and service provision. The experience of multiple impairments is more than the sum of each impairment alone.[8] In that regard, combined vision and hearing loss, also known as dual sensory impairment, is associated with reduced social participation[17] and predicts social isolation and loneliness.[18]

To date, only two cross-sectional studies have investigated the associations of tooth loss, vision, and hearing impairments with social participation among community-dwelling older adults. A study in Japan found that self-reported vision, hearing and tooth loss were associated with fewer social interactions with friends, after adjustment for sex, age, education, residence area, chronic conditions, and depressive symptoms. The magnitude of impairment was largest in vision, followed by tooth and hearing loss.[19] A study in China showed that social participation was positively associated with the self-reported number of teeth, after adjustment for sociodemographic factors, health behaviors, sleep duration, physical functioning, comorbidities, and cognitive function.[20] Longitudinal studies from other countries with aging populations would be valuable to confirm these preliminary findings. Brazil has one of the largest aging populations in the world, with a quarter of its population aged 50 or more years (equivalent to 54 million people) and 30 million Brazilians aged 60 or more years.[21] This study aimed to evaluate the associations of tooth loss, vision, and hearing impairments with social participation among older Brazilian adults over 9 years. The following research question guided this study: are tooth, vision, and hearing loss associated with declines in social participation among older Brazilian adults?

Key points

- Tooth loss, vision, and hearing impairments were associated with declines in social participation among community-dwelling older adults.
- Preserving a functional dentition into older age is as important as maintaining good vision and hearing to enjoy social activities.

Why does this paper matter?

Tooth loss, hearing, and vision impairments in older Brazilian adults are associated with a decline in the level of social participation. These factors may contribute to reductions in general health and quality of life.

METHODS

This study adheres to the strengthening the reporting of observational studies (STROBE) recommendations.[22]

Participants

This analysis used data from the Health, Wellbeing and Aging Study (SABE), a multicenter survey in seven urban cities in Latin America and the Caribbean that started in 2000.[23] In Brazil, SABE recruited a representative sample of community-dwelling adults, aged 60 or more years, from urban areas in Sao Paulo. Participants have been reassessed on up to three occasions to date, namely in 2006, 2010, and 2015. A refreshment sample of 60-64-year-olds is recruited in every new wave to maintain the age profile of the resulting cohort, which then becomes part of the cohort issued again at subsequent waves. SABE has recruited four cohorts to date: cohort A started in 2000 and was re-assessed in 2006, 2010, and 2015, cohort B started in 2006 and was re-assessed in 2010 and 2015, cohort C started in 2010 and was re-assessed in 2015, and cohort D started in 2015 (Table S1). The SABE protocol was approved by the Ethics in Research Committee of the School of Public Health at the University of Sao Paulo. Participation was voluntary and all participants provided written informed consent.

We used data from waves 2 (2006), 3 (2010), and 4 (2015) of SABE because the baseline survey (2000) did not include a clinical oral examination. Of the 1413, 1333, and 1224 participants in each wave, 1177, 1076, and 1077, respectively, were included in this study as they had information on all relevant variables (Table S1). The median follow-up time was 9 years (range: 8–11).

Variables

Social participation was the dependent variable, which was measured with seven items on current participation in formal and informal social activities.[24] Formal activities were (i) attending organized social events (clubs, community and religious groups, etc.) and (ii) doing volunteer work outside the home. Informal activities were (iii) visiting friends and family in their homes, (iv) providing care or assistance to others (transportation, running errands, etc.), (v) going out with others to public places, (vi) traveling out of town for at least an overnight stay, and (vii) inviting people home for a meal or entertainment. These activities were chosen as they require face-to-face interaction with others. Responses were captured with a 5-point scale (always, often, occasionally, rarely, and never) in 2006, a 4-point scale (often, occasionally, rarely, and never) in 2010 and a binary scale (yes/no) in 2015. Ordinal responses were dichotomized as no (never) versus yes (any other option) to match the binary responses in 2015. The number of positive responses was counted to create a summary score that ranged from 0 to 7. Higher scores corresponded to greater social participation in face-to-face activities.

Tooth loss, vision, and hearing impairments were the main explanatory variables. The number of natural teeth was determined during clinical oral examinations by trained dentists following the World Health Organization (WHO) protocol.[25] Participants were classified as having none, 1–19 and 20 or more teeth (reference group). These cut-off points were chosen because having 20 or more teeth is considered a functional dentition whereas complete tooth loss reflects the worst oral health outcome.[26] The replacement of missing teeth with dental prostheses is not considered in this definition. Participants rated their current vision and hearing using ordinal scales (very good, good, regular, poor, very poor, and blind). Participants wearing glasses or hearing devices were asked to provide their rating considering the use of these aids. Responses were combined into three categories, namely good (very good or good), regular and poor (poor, very poor, and blind). We also counted the number of times participants were in the worst group for each impairment (no teeth, poor vision, and poor hearing).

Sociodemographic factors (sex, age, living arrangement, and education), behaviors (smoking status, physical activity, and alcohol intake) and health status were the covariates included in the analysis. Living arrangement was classified as living alone or living with others (with ≥1 people). Education level was measured by the years of schooling and classified as low (≤3 years), middle (4–7 years) or high (≥8 years). Smoking status was measured with questions on lifetime tobacco use and classified as non-smoker, ex-smoker, or smoker. Physical activity was measured using the International Physical Activity Questionnaire (IPAQ). Participants were considered as physically active if they reported ≥150 min of moderate activity or ≥75 min of vigorous activity weekly.[27] Alcohol intake was measured using the Short Michigan Alcoholism Screening Test-Geriatric version (SMAST-G) and classified as no use, use, or misuse. Health status was assessed based on the following self-reported doctor-diagnosed chronic conditions: hypertension, diabetes, cardiovascular disease, and stroke. Finally, the short version of the Geriatric Depression Scale (GDS) was used to classify participants as having depressive symptoms (score >6) or not.

TABLE 1 Characteristics of the study sample ($n = 1947$), by covariates and waves.

	2006 ($n = 1177$)		2010 ($n = 1076$)		2015 ($n = 1077$)	
	n	**%**	***n***	**%**	***n***	**%**
Sex						
Men	445	37.8	383	35.6	375	34.8
Women	732	62.2	693	64.4	702	65.2
Age[a]						
60-69 years	476	40.4	522	48.5	637	59.1
70–79 years	380	32.3	303	28.2	265	24.6
80+ years	321	27.3	251	23.3	175	16.2
Living arrangement						
Living with others	979	83.2	913	84.9	886	82.3
Living alone	198	16.8	163	15.1	191	17.7
Education						
Low	563	47.8	433	40.2	328	30.5
Middle	419	35.6	400	37.2	404	37.5
High	195	16.6	243	22.6	345	32.0
Smoking status						
Non-smoker	645	54.8	557	51.8	541	50.2
Smoker	126	10.7	119	11.1	140	13.0
Ex-smoker	406	34.5	400	37.2	396	36.8
Physical activity						
No	499	42.4	648	60.2	645	59.9
Yes	678	57.6	428	39.8	432	40.1
Alcohol intake						
No use	859	73.0	767	71.3	752	69.8
Use	261	22.2	277	25.7	305	28.3
Misuse	57	4.8	32	3.0	20	1.9
Hypertension						
No	425	36.1	317	29.5	321	29.8
Yes	752	63.9	759	70.5	756	70.2
Diabetes						
No	944	80.2	789	73.3	753	69.9
Yes	233	19.8	287	26.7	324	30.1
Cardiovascular disease						
No	887	75.4	788	73.2	787	73.1
Yes	290	24.6	288	26.8	290	26.9
Stroke						
No	1090	92.6	994	92.4	988	91.7
Yes	87	7.4	82	7.6	89	8.3
GDS score						
0–6	984	83.6	860	79.9	874	81.2
6+	193	16.4	216	20.1	203	18.8
Tooth loss						
20+ teeth left	161	13.7	197	18.3	226	21.0

TABLE 1 (Continued)

	2006 ($n = 1177$)		2010 ($n = 1076$)		2015 ($n = 1077$)	
	n	%	*n*	%	*n*	%
1–19 teeth left	420	35.7	427	39.7	476	44.2
No teeth left	596	50.6	452	42.0	375	34.8
Vision						
Good	663	56.3	585	54.4	529	49.1
Regular	346	29.4	371	34.5	422	39.2
Poor	168	14.3	120	11.2	126	11.7
Hearing						
Good	242	20.6	225	20.9	191	17.7
Regular	616	52.3	470	43.7	527	48.9
Poor	319	27.1	381	35.4	359	33.3

Abbreviation: GDS, Geriatric Depression Scale.
[a]Three age groups were chosen for presentation purposes only.

Data analysis

All analyses were conducted in Stata 17 (StataCorp LP, College Station, TX). The characteristics of the study sample were first presented by waves. Next, the social participation score at every wave was compared between groups defined by each impairment (tooth, vision, and hearing loss) and all covariates. These comparisons were made in unadjusted negative binomial regression models as the outcome was a count variable with over-dispersion.

The association of each impairment with the 9-year change in the social participation score was examined in negative binomial mixed-effects models, with three waves (level 1) clustered within participants (level 2). First, a random slope model with age as the only predictor was fitted to estimate the annual rate of change in the social participation score. Then, the association between impairments and the social participation score was tested in a confounder-adjusted model. Two regression coefficients were estimated for each impairment. The first captured differences in the baseline social participation score (intercept) between groups with different levels of impairment while the second captured differences in the annual rate of change in the social participation score (slope) between groups with different levels of impairment.[28,29] These coefficients correspond to the main effect of the impairment and its interaction with time, respectively.[28] Age in years (continuous form) was used as the time indicator in all models and modeled as a random effect, which allowed for individual variations in the baseline social participation score (random intercept) and in the rate of change in the social participation score over time (random slope). The coefficients for the three impairments and all covariates were estimated as fixed effects. All model predictors, but sex and education, were time-variant. All variances and the covariance between the intercept and slope of the social participation score were estimated uniquely from the data (unstructured covariance matrix).[28,29] The same modeling strategy was used to examine the association between the number of impairments and the 9-year change in the social participation score. The mixed-effects models were fitted using the second-order penalized quasi-likelihood linearization estimation algorithm in MLwiN 3.05 (Centre for Multilevel Modeling, University of Bristol, UK), which was called from Stata with the package *runmlwin*.[30]

RESULTS

Data from 1947 individuals were analyzed. Of them, 383 had three waves of data, 617 had two waves of data and 947 had one wave of data (either 2006, 2010, or 2015). Participants with 3 waves of data were more likely to be female, 70–79 years old, physically active and have good vision as well as less likely to be smokers and have higher education and depressive symptoms than participants with fewer waves of data (Table S2). The characteristics of participants in the study sample are shown in Table 1. Their mean age was 73.2 ± 8.8, 71.8 ± 9.2, and 70.4 ± 8.4 years in waves 2, 3, and 4, respectively. The mean social participation score was 3.9 ± 1.7 (range: 0–7, % zero values: 3.1%) in wave 2, 3.5 ± 1.8 (range: 0–7, % zero values: 5.9%) in wave 3 and 4.0 ± 1.6 (range: 0–7, % zero values: 3.2%) in wave 4. In terms of impairments, 50.6%, 42.0%, and 34.8% were edentulous, 14.3%, 11.2%, and 11.7% reported

TABLE 2 Cross-sectional differences in the social participation score by covariates ($n = 1947$).

	Mean social participation score (SD)					
	2006 ($n = 1177$)		**2010 ($n = 1076$)**		**2015 ($n = 1077$)**	
Sex						
Men	3.7	(1.7)	3.2	(1.8)	3.8	(1.7)
Women	4.0	(1.7)	3.7	(1.8)	4.1	(1.6)
p value[a]	0.051		<0.001		0.019	
Age						
60–69 years	4.3	(1.6)	3.7	(1.8)	4.1	(1.5)
70–79 years	4.0	(1.6)	3.8	(1.8)	4.1	(1.6)
80+ years	3.2	(1.7)	2.8	(1.9)	3.3	(1.8)
p value	<0.001		<0.001		<0.001	
Living arrangement						
Living with others	3.9	(1.7)	3.5	(1.9)	4.0	(1.6)
Living alone	3.6	(1.8)	3.5	(1.8)	3.9	(1.7)
P value	0.011		0.967		0.890	
Education						
Low	3.5	(1.6)	3.1	(1.8)	3.6	(1.7)
Middle	4.1	(1.7)	3.5	(1.8)	3.9	(1.6)
High	4.6	(1.5)	4.3	(1.8)	4.4	(1.5)
p value for trend	<0.001		<0.001		<0.001	
Smoking status						
Non-smoker	4.0	(1.7)	3.8	(1.8)	4.1	(1.7)
Smoker	3.8	(1.7)	3.2	(1.8)	3.8	(1.6)
Ex-smoker	3.7	(1.6)	3.4	(1.9)	3.7	(1.7)
p value	0.059		<0.001		0.008	
Physical activity						
No	3.6	(1.8)	3.5	(2.0)	3.8	(1.7)
Yes	4.1	(1.6)	3.5	(1.7)	4.2	(1.5)
p value	<0.001		0.833		0.001	
Alcohol intake						
No use	3.7	(1.7)	3.4	(1.9)	3.9	(1.6)
Use	4.5	(1.5)	4.0	(1.7)	4.2	(1.6)
Misuse	3.6	(1.5)	3.0	(1.9)	3.5	(1.9)
p value	<0.001		0.002		0.057	
Hypertension						
No	3.9	(1.7)	3.8	(1.8)	4.2	(1.5)
Yes	3.8	(1.7)	3.4	(1.8)	3.9	(1.7)
p value	0.431		0.002		0.023	
Diabetes						
No	3.9	(1.7)	3.5	(1.8)	4.0	(1.6)
Yes	3.9	(1.7)	3.5	(1.8)	3.9	(1.6)
p value	0.611		0.514		0.219	
Cardiovascular disease						
No	3.9	(1.7)	3.6	(1.9)	4.0	(1.6)

TABLE 2 (Continued)

	Mean social participation score (SD)					
	2006 ($n = 1177$)		**2010 ($n = 1076$)**		**2015 ($n = 1077$)**	
Yes	3.7	(1.7)	3.3	(1.8)	3.8	(1.7)
p value	0.144		0.039		0.067	
Stroke						
No	4.0	(1.7)	3.6	(1.8)	4.0	(1.6)
Yes	2.9	(1.8)	2.7	(1.9)	3.5	(1.7)
p value	<0.001		<0.001		0.027	
GDS score						
<6	4.0	(1.7)	3.7	(1.8)	4.1	(1.5)
6+	3.1	(1.6)	2.7	(1.8)	3.2	(1.8)
p value	<0.001		<0.001		<0.001	
Tooth loss						
20+ teeth left	4.5	(1.5)	3.9	(1.9)	4.4	(1.4)
1–19 teeth left	4.1	(1.7)	3.6	(1.8)	4.0	(1.6)
No teeth left	3.6	(1.7)	3.2	(1.8)	3.7	(1.7)
p value	<0.001		<0.001		<0.001	
Vision						
Good	4.2	(1.6)	3.8	(1.8)	4.1	(1.6)
Regular	3.8	(1.6)	3.4	(1.8)	4.0	(1.5)
Poor	2.9	(1.8)	2.6	(1.8)	3.2	(1.8)
p value	<0.001		<0.001		<0.001	
Hearing						
Good	4.2	(1.7)	3.9	(1.9)	4.3	(1.7)
Regular	3.9	(1.7)	3.5	(1.8)	4.0	(1.6)
Poor	3.6	(1.7)	3.3	(1.9)	3.7	(1.7)
p value	<0.001		<0.001		<0.001	

Abbreviation: GDS, Geriatric Depression Scale.

[a]*p* values derived from unadjusted negative binomial regression models.

poor vision and 27.1%, 35.4%, and 33.3% reported poor hearing in waves 2, 3, and 4, respectively.

Inverse gradients in the social participation score according to each impairment were found in every wave (Table 2). Participants with fewer teeth, poorer vision, and poorer hearing also had lower social participation scores. Older and less educated participants and those with depressive symptoms and a history of stroke also had lower social participation scores in every wave than their respective counterparts. Drinking participants had lower social participation scores in waves 2 and 3 than non-drinking participants. Men, smokers, and participants with a history of hypertension had lower social participation scores in waves 3 and 4 than their corresponding counterparts. Physically inactive participants had lower social participation scores in waves 2 and 4 than physically active participants. Participants living alone and those with a history of cardiovascular disease had lower social participation scores in waves 2 and 3 than those living with others and without such a history, respectively.

The random slope model showed that the social participation score was lower by 2% (IRR: 0.98, 95% CI: 0.98–0.99) for every higher year in age. The unexplained variances for the intercept and slope were 0.33 (95% CI: 0.31–0.36) and 0.001 (95% CI: 0.001–0.001), respectively. The negative intercept-slope covariance (−0.006; 95% CI: −0.008 to −0.005) meant that participants with the highest baseline social participation scores had the steepest declines in scores over time. In the confounder-adjusted mixed effects model (Table 3), each impairment was inversely associated with the social participation score at baseline. Participants with 1–19 (0.96, 95% CI: 0.91–1.01)

TABLE 3 Negative binomial mixed-effects model for the associations of tooth loss, vision, and hearing impairments with the social participation score among older Brazilian adults ($n = 3330$ repeated assessments in 1947 participants).

Fixed effects	IRR[a]	[95% CI]	*p* value
Age, years	1.00	[0.99, 1.01]	0.626
Tooth loss			
20+ teeth left	1.00	[Reference]	
1–19 teeth left	0.96	[0.91, 1.01]	0.107
No teeth left	0.92	[0.87, 0.97]	0.002
Tooth loss × Age			
20+ teeth left × Age	1.00	[Reference]	
1–19 teeth left × Age	0.996	[0.990, 1.002]	0.183
No teeth left × Age	0.994	[0.987, 0.999]	0.043
Vision			
Good	1.00	[Reference]	
Regular	0.98	[0.95, 1.01]	0.171
Poor	0.86	[0.81, 0.90]	<0.001
Vision × Age			
Good × Age	1.00	[Reference]	
Regular × Age	0.996	[0.992, 0.999]	0.029
Poor × Age	0.997	[0.991, 1.003]	0.285
Hearing			
Good	1.00	[Reference]	
Regular	0.94	[0.91, 0.98]	0.001
Poor	0.91	[0.87, 0.95]	<0.001
Hearing × Age			
Good × Age	1.00	[Reference]	
Regular × Age	0.997	[0.992, 1.001]	0.137
Poor × Age	0.995	[0.990, 0.999]	0.048
Intercept	4.04	[3.75, 4.35]	<0.001
Random effects	**Estimate**	**[95% CI]**	
Variance (slope)	0.0002	[0.0001, 0.0003]	
Variance (intercept)	0.05	[0.04, 0.06]	
Covariance (slope, intercept)	0.001	[0.0004, 0.002]	

[a]A two-level negative binomial mixed-effects model, with repeated observations (level 1) nested within participants (level 2), was fitted. Incidence rate ratios (IRR) were reported. Age (continuous form) was used as the time indicator. The model was adjusted for sex, living arrangement, education, smoking status, physical activity, alcohol intake, GDS score, history of hypertension, diabetes, cardiovascular disease and stroke, and the pairwise interactions of sex, education and physical activity with age.

TABLE 4 Negative binomial mixed-effects model for the association between the number of impairments and the social participation score among older Brazilian adults (n = 3330 repeated assessments in 1947 participants).

Fixed effects	IRR[a]	[95% CI]	*p* value
Age, years	0.99	[0.99, 0.99]	0.046
Number of impairments			
None	1.00	[Reference]	
One	0.94	[0.91, 0.97]	0.001
Two	0.88	[0.84, 0.93]	<0.001
Three	0.70	[0.62, 0.79]	<0.001
Number of impairments × Age			
None × Age	1.00	[Reference]	
One × Age	0.996	[0.992, 0.999]	0.041
Two × Age	0.995	[0.989, 1.000]	0.068
Three × Age	0.997	[0.985, 1.008]	0.557
Intercept	3.71	[3.51, 3.93]	<0.001
Random effects	**Estimate**	**[95% CI]**	
Variance (slope)	0.0002	[0.0001, 0.0003]	
Variance (intercept)	0.81	[0.20, 1.42]	
Covariance (slope, intercept)	−0.01	[0.004, −0.02]	

[a]A two-level negative binomial mixed-effects model, with repeated observations (level 1) nested within participants (level 2), was fitted. Incidence rate ratios (IRR) were reported. Age (continuous form) was used as the time indicator. The model was adjusted for sex, living arrangement, education, smoking status, physical activity, alcohol intake, GDS score, history of hypertension, diabetes, cardiovascular disease and stroke, and the pairwise interactions of sex, education and physical activity with age.

and no teeth (0.92, 95% CI: 0.87–0.97), those with regular (0.98, 95% CI: 0.95–1.01) and poor vision (0.86, 95% CI: 0.81–0.90), and those with regular (0.94, 95% CI: 0.91–0.98) and poor hearing (0.91, 95% CI: 0.87–0.95) had lower baseline social participation scores than those with 20+ teeth, good vision, and good hearing, respectively. In addition, the interactions of each impairment with age indicated that tooth loss, vision, and hearing impairments were associated with greater declines in the social participation score. Participants with 1–19 (0.996, 95% CI: 0.990–1.002) and no teeth (0.994, 95% CI: 0.987–0.999), those with regular (0.996, 95% CI: 0.992–0.999) and poor vision (0.997, 95% CI: 0.991–1.003), and those with regular (0.997, 95% CI: 0.992–1.001) and poor hearing (0.995, 95% CI: 0.990–0.999) had greater declines in the social participation score than those with 20+ teeth, good vision, and good hearing, respectively.

In terms of the number of impairments, 43.3%, 18.6%, and 3.8% of participants in wave 2, 42.5%, 17.8%, and 3.5% of participants in wave 3, and 40.4%, 16.0%, and 2.5% of participants in wave 4 had one, two and three impairments, respectively. In the confounder-adjusted model, the number of impairments was inversely associated with the social participation score at baseline (Table 4). Participants with one (0.94, 95% CI: 0.91–0.97), two (0.88, 95% CI: 0.84–0.93) and three impairments (0.70, 95% CI: 0.62–0.79)

had, respectively, lower social participation scores than those with no impairments. The interaction with age indicated that having more impairments was associated with greater declines in the social participation score over time. Participants with one (0.996, 95% CI: 0.992–0.999), two (0.995, 95% CI: 0.989–1.000) and three impairments (0.997, 95% CI: 0.985–1.008) had, respectively, greater declines in the social participation score than those with no impairments.

DISCUSSION

This 9-year longitudinal study shows that tooth loss, hearing and vision impairments were associated with declines in social participation among older Brazilian adults. Furthermore, the accumulation of the three impairments was associated with declines in social participation. These effects were independent of sociodemographic factors, behaviors, and medical conditions, all of which are known to be strong determinants of social participation,[4] loneliness,[31] and social isolation.[32]

This study has some limitations worth mentioning. First, we used observational data and, therefore, the findings do not support any conclusion about causality. However, the use of longitudinal data supports conclusions about temporality. Second, relying on self-reported data on sensory impairments (vision and hearing loss) and social participation could introduce measurement bias. Having said that, the study has the advantages of using longitudinal data to assess change in social participation over 9 years and using time-varying measures for the exposure and covariates in the analysis. The use of panel data analysis allows accounting for the change in exposure and outcome over time. The analysis accounted for several established determinants of social participation and still demonstrated a significant association with the three impairments when analyzed separately in the same model and when used as an aggregate variable of impairment.

Our findings confirm those from an earlier study in Japan.[19] However, the current analysis has the advantage of using longitudinal data and time-varying exposures, thus allowing assessment of the relationship between change in exposures and change in outcome over 9 years. The associations observed might be related to the fact that tooth, hearing, and vision loss can each impair social interactions and participation, which could subsequently lead to loneliness and social isolation.[16,32] It thus follows that preserving a functional dentition into older age is as important as maintaining good vision and hearing to enjoy most social activities. This interpretation is further supported by the common finding in both studies that experiencing multiple impairments was associated with fewer social interactions with friends and reduced participation in face-to-face daily activities, respectively.

Despite their similar impact on social participation, tooth loss can affect social participation through different mechanisms to those of vision and hearing loss. Vision and hearing impairments can lead to difficulties with mobility (i.e., reduced ability to walk and drive) and inability to accomplish activities of daily living, especially given the importance of binaural and binocular cues to navigation and engaged communication in complex everyday situations.[33] On the other hand, older adults with tooth loss are more likely to feel embarrassed and less confident,[12,13] which can result in the avoidance of eating in public and socializing with others as maladaptive mechanisms.[14,15]

The findings of the current analysis highlight the important role of having functional hearing, vision, and dentition in maintaining and enjoying social interaction, an important determinant of healthy aging.[1,2] This is increasingly relevant nowadays given that social isolation and loneliness are becoming common in the aging populations.[34] The findings could be beneficial for social and health promotion activities aiming at improving social interaction among older adults. Furthermore, the association between changes in tooth loss and decline in social participation observed here provides evidence for a plausible pathway between tooth loss and general health, beyond the inflammatory and nutritional pathways commonly cited in the literature.[35] This research area would benefit from more prospective studies including multiple assessments of impairments that go beyond the use of self-reports. Clinical measures of sensory impairment (visual acuity and audiometric tests) would be valuable to confirm the present findings.[33] In addition, the comprehensive evaluation of social participation could facilitate the study of active aging and identify domains for intervention.[1] Further research could also evaluate whether the use of dental prostheses and adequate hearing aids and glasses could improve participation in social activities among older adults experiencing tooth loss, hearing and vision impairments.

In conclusion, this research used longitudinal data from SABE and demonstrated that tooth loss, hearing, and vision impairments were important and independent determinants of social participation among older Brazilian adults. The findings also demonstrated that the accumulation of these impairments is associated with additional reductions in social interaction and could have severe impacts on the quality of life and general health of older adults. The findings will potentially be beneficial for social and health promotion interventions aiming at maintaining good health at an older age.

AUTHOR CONTRIBUTIONS

Eduardo Bernabé and Wael Sabbah conceptualized the study. Eduardo Bernabé carried out the analyses. Fabiola Bof de Andrade, Cesar de Oliveira, Eduardo Bernabé, Yeda Aparecida de Oliveira Duarte, and Wael Sabbah contributed to the interpretation of the results and drafted and revised the article. All authors approved the final article as submitted and agree to be accountable for all aspects of the work.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

SPONSOR'S ROLE

Nothing to declare.

ORCID

Eduardo Bernabé https://orcid.org/0000-0002-1858-3713
Cesar de Oliveira https://orcid.org/0000-0002-4099-4762
Yeda Aparecida de Oliveira Duarte https://orcid.org/0000-0003-3933-2179
Fabiola Bof de Andrade https://orcid.org/0000-0002-3467-3989
Wael Sabbah https://orcid.org/0000-0002-6339-9480

REFERENCES

1. Levasseur M, Lussier-Therrien M, Biron ML, et al. Scoping study of definitions of social participation: update and co-construction of an interdisciplinary consensual definition. *Age Ageing*. 2022;51(2):afab215.
2. Douglas H, Georgiou A, Westbrook J. Social participation as an indicator of successful aging: an overview of concepts and their associations with health. *Aust Health Rev*. 2017;41(4):455-462.
3. Kelly ME, Duff H, Kelly S, et al. The impact of social activities, social networks, social support and social relationships on the cognitive functioning of healthy older adults: a systematic review. *Syst Rev*. 2017;6(1):259.
4. Townsend BG, Chen JT, Wuthrich VM. Barriers and facilitators to social participation in older adults: a systematic literature review. *Clin Gerontol*. 2021;44(4):359-380.
5. Levasseur M, Genereux M, Bruneau JF, et al. Importance of proximity to resources, social support, transportation and neighborhood security for mobility and social participation in older adults: results from a scoping study. *BMC Public Health*. 2015;15:503.
6. Blindness GBD, Vision Impairment C, Vision Loss Expert Group of the Global Burden of Disease Study. Trends in prevalence of blindness and distance and near vision impairment over 30 years: an analysis for the Global Burden of Disease Study. *Lancet Glob Health*. 2021;9(2):e130-e143.
7. Collaborators GBDHL. Hearing loss prevalence and years lived with disability, 1990–2019: findings from the Global Burden of Disease Study 2019. *Lancet*. 2021;397(10278):996-1009.
8. Schneider JM, Gopinath B, McMahon CM, Leeder SR, Mitchell P, Wang JJ. Dual sensory impairment in older age. *J Aging Health*. 2011;23(8):1309-1324.
9. Shah K, Frank CR, Ehrlich JR. The association between vision impairment and social participation in community-dwelling adults: a systematic review. *Eye (Lond)*. 2020;34(2):290-298.
10. Shukla A, Harper M, Pedersen E, et al. Hearing loss, loneliness, and social isolation: a systematic review. *Otolaryngol Head Neck Surg*. 2020;162(5):622-633.
11. Collaborators GBDOD, Bernabe E, Marcenes W, et al. Global, regional, and national levels and trends in burden of oral conditions from 1990 to 2017: a systematic analysis for the Global Burden of Disease 2017 Study. *J Dent Res*. 2020;99(4):362-373.
12. Tan H, Peres KG, Peres MA. Retention of teeth and oral health-related quality of life. *J Dent Res*. 2016;95(12):1350-1357.
13. Atanda AJ, Livinski AA, London SD, et al. Tooth retention, health, and quality of life in older adults: a scoping review. *BMC Oral Health*. 2022;22(1):185.
14. 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.
15. Al-Sahan MM, MacEntee MI, Bryant SR. A metatheory explaining how patients manage tooth loss. *Gerodontology*. 2020;37(3):258-270.
16. Abbas H, Aida J, Cooray U, et al. Does remaining teeth and dental prosthesis associate with social isolation? A six-year longitudinal study from the Japan Gerontological Evaluation Study (JAGES). *Community Dent Oral Epidemiol*. 2023;51(2):345-354.
17. Viljanen A, Tormakangas T, Vestergaard S, Andersen-Ranberg K. Dual sensory loss and social participation in older Europeans. *Eur J Ageing*. 2014;11(2):155-167.
18. Wang Q, Zhang S, Wang Y, Zhao D, Zhou C. Dual sensory impairment as a predictor of loneliness and isolation in older adults: National Cohort Study. *JMIR Public Health Surveill*. 2022;8(11):e39314.
19. Igarashi A, Aida J, Yamamoto T, Hiratsuka Y, Kondo K, Osaka K. Associations between vision, hearing and tooth loss and social interactions: the JAGES cross-sectional study. *J Epidemiol Community Health*. 2021;75(2):171-176.
20. Yang L, Guo D, Zheng J, Guo Y, Li Z. Association between social participation and remaining teeth and urban-rural difference among older adults in China. *Int J Environ Res Public Health*. 2023;20(2):1283.
21. Lima-Costa MF, de Melo Mambrini JV, Bof de Andrade F, et al. Cohort profile: the Brazilian longitudinal study of ageing (ELSI-Brazil). *Int J Epidemiol*. 2023;52(1):e57-e65.
22. Vandenbroucke JP, von Elm E, Altman DG, et al. Strengthening the reporting of observational studies in epidemiology (STROBE): explanation and elaboration. *Ann Intern Med*. 2007;147(8):W163-W194.
23. Lebrao ML, Duarte YAO, Santos JLF, Silva NND. 10 years of SABE study: background, methodology and organization of the study. *Rev Bras Epidemiol*. 2019;21(Suppl 02):e180002.
24. Levasseur M, Richard L, Gauvin L, Raymond E. Inventory and analysis of definitions of social participation found in the aging literature: proposed taxonomy of social activities. *Soc Sci Med*. 2010;71(12):2141-2149.

25. WHO. *Oral Health Surveys—Basic Methods*. 4th ed. World Health Organization; 1997.
26. Hobdell M, Petersen PE, Clarkson J, Johnson N. Global goals for oral health 2020. *Int Dent J*. 2003;53(5):285-288.
27. WHO. *Global Recommendations on Physical Activity for Health*. World Health Organization; 2010.
28. Singer JD, Willett JB. *Applied Longitudinal Data Analysis: Modeling Change and Event Occurrence*. Oxford University Press; 2003.
29. Twisk JWR. *Applied Longitudinal Data Analysis for Epidemiology: A Practical Guide*. Cambridge University Press; 2013.
30. Leckie G, Charlton C. runmlwin—a program to run the MLwiN multilevel modelling software from within Stata. *J Stat Softw*. 2013;52(11):1-40.
31. Dahlberg L, McKee KJ, Frank A, Naseer M. A systematic review of longitudinal risk factors for loneliness in older adults. *Aging Ment Health*. 2022;26(2):225-249.
32. Wen Z, Peng S, Yang L, et al. Factors associated with social isolation in older adults: a systematic review and meta-analysis. *J Am Med Dir Assoc*. 2023;24(3):322-330 e326.
33. Hamalainen A, Pichora-Fuller MK, Wittich W, Phillips NA, Mick P. Self-report measures of hearing and vision in older adults participating in the Canadian longitudinal study of aging are explained by behavioral sensory measures, demographic, and social factors. *Ear Hear*. 2021;42(4):814-831.
34. Chawla K, Kunonga TP, Stow D, Barker R, Craig D, Hanratty B. Prevalence of loneliness amongst older people in high-income countries: a systematic review and meta-analysis. *PLoS One*. 2021;16(7):e0255088.
35. Thomson WM, Barak Y. Tooth loss and dementia: a critical examination. *J Dent Res*. 2021;100(3):226-231.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

Table S1. Number of participants recruited and analyzed by SABE cohort and attrition.

Table S2. Comparison of sociodemographic factors, behaviors, and health status between participants with 1, 2, and 3 waves of data.

How to cite this article: Bernabé E, de Oliveira C, de Oliveira Duarte YA, Bof de Andrade F, Sabbah W. Social participation and tooth loss, vision, and hearing impairments among older Brazilian adults. *J Am Geriatr Soc*. 2023;1-11. doi:10.1111/jgs.18423