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Longitudinal association between dentition status and gait speed among older Brazilian adults: SABE cohort study

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Abstract

Background Oral health has been associated with general health conditions, but few longitudinal studies evaluated the effect of dentition status on gait speed.

Objective This study aimed to investigate the longitudinal association between different time-varying measures of dentition status (i.e., number of teeth, the presence of periodontal pockets and the functional impact of oral health) and gait speed (outcome) in older Brazilian adults.

Materials and methods This was a prospective study using data from the Health, Well-being and Aging cohort study (SABE) from 2006, 2010 and 2015. The gait speed was the dependent variable and the independent variables of interest were dentition status evaluated using the number of teeth, use of dental prostheses, presence of periodontal pocket, clinical attachment loss and self-perceived poor functional oral health. Dentition status measures were obtained through clinical oral examinations, performed by trained dentists using standardized criteria proposed by the World Health Organization. Self-perceived poor functional oral health was evaluated using the functional domain of the Geriatric Oral Health Assessment Index. The longitudinal effect of dentition status on gait speed was evaluated using mixed-effects linear models. The effect of the number of teeth/periodontal pocket/attachment loss on gait speed change over time was evaluated by including an interaction term between these variables. The effect of periodontal pocket was tested only among dentate individuals.

Results Data for the complete sample included 3,306 observations from 1,964 individuals. The analyses for dentate individuals included 1,883 observations from 1,149 individuals. There was a positive association between the number of teeth and mean gait speed. Individuals using dental prostheses also had higher means of gait speed than those without dental prostheses. Gait speed was lower among individuals with periodontal pockets and with attachment loss. No interaction was found between any of the indicators of dentition status and time.

Conclusion Gait speed was associated with dentition status and this association was constant over time.

Keywords Oral health, Tooth loss, Periodontal disease, Walking speed, Cohort studies

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Introduction

Maintaining physical performance is essential for independence as people age [1]. The gait speed is an important measure in assessing geriatric syndromes, as it is a marker of functional decline and general health status [2–5]. Declines in gait speed have been associated with an increased risk of falls [3], limitation in performing activities of daily living [2, 6–8] and mortality [9–11]. As a result, identifying factors that can predict a decline in gait speed is essential for public health.

Normal gait speed is expected to decline with age, slowing by a decade among males, 50 or more years old, and females 30 years or older [12]. The presence of chronic conditions, such as cognitive decline [13], are also known to be associated with gait speed decline. In addition, cognitive performance has been found to interact with age and increase the rate of declines in older adults [14].

Impaired oral health has been suggested as an indicator of general health decline due to its direct relationship with essential functions such as eating, breathing, and speaking [15]. Reduced masticatory ability limits food choices and nutrition [16–19] and, together with the infection and inflammation resulting from periodontal disease, might contribute to functional decline and increase the risk of systemic diseases, such as cardiovascular disease and diabetes [20–23]. Periodontal disease can lead to low-grade systemic inflammation. Individuals with severe disease have been found to exhibit higher levels of pro-inflammatory mediators and an increased number of neutrophils in the blood [24].

The association between oral health conditions (exposure) and gait speed (outcome) has mostly been investigated through cross-sectional studies [25–30]. However, only few longitudinal studies have shown that partial [31] and complete tooth loss [31, 32], lack of posterior occlusal support [33] and poor periodontal status [34] at baseline predicted lower gait speed. Out of these studies, only two had clinically assessed oral health measures [33, 34]. In addition, only a single study [34] has evaluated the longitudinal association between gait speed and multiple oral health measures, including subjective evaluation, such as self-rated oral health and perceived difficulty in eating or chewing. These subjective measures complement clinical measures as they reflect the individuals' perceptions and judgment regarding their health and how oral health affects functional and psychosocial well-being [35–38]. Except for one study [34], the effect of changing oral health status has not been fully explored. Moreover, few investigations evaluated the role of inflammatory biomarkers in the association between oral health and gait speed, being the evidence inconclusive [31, 32, 34].

Given the high prevalence of dental impairment and periodontal disease and the cumulative nature of tooth loss throughout life [15], oral health is an important indicator for healthy aging. Therefore, this study aims to investigate the longitudinal association between different time-varying measures of dentition status (i.e., number of teeth, the presence of periodontal pockets and the functional impact of oral health) and gait speed (outcome) in older Brazilian adults. The study hypothesis was that the lower number of teeth and periodontal disease are associated with a reduced gait speed.

Methods

This was a prospective study using data from the Health, Well-being and Aging cohort study (SABE). SABE started in 2000, as a multicenter study in seven urban cities in Latin America and the Caribbean. In Brazil, the study was conducted in the City of São Paulo with waves conducted in a five-year approximate interval (2006, 2010 and 2015). The sample was representative of the community-dwelling older adults aged 60 years and over living in the urban region of São Paulo city, Brazil. The sample was recruited using two-stage stratified random sampling. The census track was the first stage and the household was the second. In every wave, all participants that were located were reinterviewed and a new sample of individuals aged 60–64 was included to keep the representativeness of this age group.

The initial sample in 2000 was created using a two-stage stratified random sampling method (census tract and household), based on the geographic regions defined by the 1995 National Household Survey. To address the higher mortality rate and lower likelihood of being sampled among individuals aged 75 and older, an additional sample from this age group was included. In 2000, a total of 2,143 older adults were interviewed. In 2006, 1,115 participants were re-interviewed, and 298 individuals aged between 60 and 64 were added using probabilistic randomized sampling to maintain the representativeness of this age group, resulting in a sample of 1,413 individuals. In 2010, 915 elderly participants were re-interviewed, and a new sample of 355 older adults aged 60–64 was incorporated, totaling 1,333 interviews. In 2015, the sample included 838 re-interviewed participants and 386 new individuals aged 60 to 64, bringing the total to 1,224 individuals. All interviews were conducted in the participants' homes. A detailed description of the study design and sampling can be found elsewhere [39]. Supplemental Fig. 1 illustrates the study sample included in each wave.

SABE study was approved by the Ethics in Research Committee of the School of Public Health of the University of São Paulo (protocol: wave 2006 = 1,345; wave 2010 = 2,044, wave 2015 = 47683115.4.0000.5421). Written informed consent from all the participants was obtained at the time of each interview.

The current study used data from the second, third and fourth SABE waves as clinical oral health measures were not assessed in the first wave. Only individuals with complete data for all variables of interest were analyzed in the present study, resulting in 1165 individuals in 2006, 1129 in 2010 and 1012 in 2015.

Dependent variable

Gait speed was evaluated as the time taken to walk a distance of three meters [40]. Participants took the test twice and were asked to walk the course at their normal walking speed. The shortest walking time was used to calculate gait speed in meters per second (distance in meters/time to walk the distance in seconds). The walking time was measured using a stopwatch. Gait speed was evaluated in every wave and treated as a repeated continuous variable.

Independent variables of interest

Dentition status was evaluated using the number of teeth (none, 1–10, 11–19, 20 or more) [41], use of dental prostheses [removable or fixed bridges] (no, yes) [42], presence of periodontal pocket ≥ 4 mm (no, yes), clinical attachment loss ≥ 4 mm (no, yes) and self-perceived poor functional oral health (no, yes). The number of teeth, periodontal pocket and use of dental prostheses were obtained through clinical oral examinations, performed by trained dentists using standardized criteria defined by the World Health Organization [42]. The oral health examinations were performed at the participants' homes in a place with the maximum illumination from artificial light. Subjects were examined seated in a chair or, in the case of home-bound individuals, in their usual resting place. Periodontal pockets were measured using the Community Periodontal Index (CPI). The protocol involves examining ten specific index teeth (17, 16, 11, 26, 27, 47, 46, 31, 36, 37) across six mouth sextants using a specialized WHO periodontal probe with a 0.5 mm ball tip. Only six measurements are recorded, one for each sextant, based on the highest score observed within that sextant [42].

Self-perceived poor functional oral health was evaluated using the functional domain of the Geriatric Oral Health Assessment Index [43]. This instrument consists of 12 items selected to assess oral health–related problems in three dimensions: physical function, psychosocial function and pain or discomfort. The physical function domain includes four questions related to concerns about eating, speech, swallowing and speaking due to problems with teeth or dentures. The questions were answered using a 5-point Likert scale. Participants were asked how often they had experienced such problems in the previous 12 months: always, often, sometimes, seldom, or never. Participants reporting always or often to one or more questions were classified as having poor functional oral health.

Covariates

The following covariates were included in the analyses: sociodemographic (age at baseline [age at the time the participant started to contribute in the study], sex and schooling years); behavioral factors (smoking status [no, yes, former], physical activity [no, yes] and alcohol intake [no, yes/ without risk for alcoholism, yes/ with risk for alcoholism]); general health (hypertension [no, yes], diabetes [no, yes], cardiovascular disease [no, yes], stroke [no, yes], cognitive performance, Body Mass Index [weight (kg)/height (m [2])]).

Participants were considered physically active if they reported at least 150 min of moderate or vigorous activities per week or 75 min of vigorous activity per week [44]. The International Physical Activity Questionnaire (IPAQ) was used to evaluate this measure [45]. Cognitive performance was assessed using an abbreviated Mini-Mental State Examination (MMSE) version. This instrument was specifically elaborated for the SABE study in its baseline, by Icaza and Albala [46], and used by all participating countries. Individuals reporting the use of alcohol answered the Short Michigan Alcoholism Screening Test and were classified as use with or without risk for alcoholism [47]. Chronic diseases were evaluated based on a self-report of a previous diagnosis by a physician or nurse.

Data analysis

A descriptive analysis of all variables in each wave was conducted, followed by the distribution of the outcome based on the independent variables of interest. The longitudinal effect of dentition status on gait speed was evaluated using mixed-effects linear models with three repeated assessments (level 1) nested within participants (level 2). The year of each assessment (2006, 2010 and 2015) was used as the time indicator centered on 2010. The likelihood-ratio test was used to test the model with a random effect on time against the one without random effect on time. The coefficients for time were estimated as random effects in the models using the data for the three waves, allowing for individual variations in baseline gait speed (intercept) and the rate of change in gait speed over time (slope). The coefficients for other predictors were estimated as fixed effects. All variables, except for age at baseline and sex, were included as time-varying predictors. The models were fitted with unstructured covariance. The final models were adjusted for BMI to evaluate a possible mediation effect. The effect of the number of teeth/periodontal pocket/attachment loss on gait speed change over time was assessed by including an interaction term between these variables. The effect of periodontal pocket was tested only among dentate individuals. All analyses were done using Stata software 18.0.

Since blood samples were available only for the third (2010) and fourth (2015) waves we did supplemental analyses using these two waves also to test the effect of C-reactive protein (CRP) (mg/l) and albumin (g/dl) on the associations between dentition status and gait speed.

Results

Data for the complete sample included 3,306 observations from 1,964 individuals. Of these, 347 had data on three waves, 648 had data on two waves and 969 had data on one wave. The mean age was about 73.0 years in 2006, 72.2 in 2010 and 70.3 in 2015. Most of the participants were women in all waves. Mean gait speed was 0.75 m/s, 0.76 m/s and 0.74 m/s in 2006, 2010 and 2015, respectively. The proportion of individuals with 20+teeth was 13.4% in 2006 and 21.0% in 2015. In all the waves, edentulism affects the higher proportion of the sample. Poor functional dentition was reported by 33% of participants in the first and second waves and 23% in the third (Table 1).

In each wave, mean gait speed was higher among individuals with any teeth and no poor functional oral health than in edentulous or individuals with poor functional oral health, respectively. No differences in the mean gait speed were found regarding the presence of periodontal pockets (Table 2).

The intraclass correlation coefficient (ICC) of the null model showed that about 44% of the variation in the outcome was explained by between-individual differences. Unadjusted and adjusted models for the association between dentition status and gait speed over time for the total sample are presented in Table 3. The fully adjusted model for the total sample (Table 3, Model 4) showed a positive association between the number of teeth and mean gait speed. Individuals in any of the teeth categorizations and using dental prostheses had higher means of gait speed than edentulous and those without dental prostheses. Gait speed was 0.019 m/s lower among participants with poor functional oral health than those with good. There was no attenuation on the coefficients for indicators of dentition status after adjustment for BMI (Model 4). Gait speed decreased by about 0.011 m/s in the adjusted models. No interaction was found between any of the indicators of dentition status and time, suggesting that the effect of the number of teeth, use of dental prostheses and poor functional oral health on gait speed was constant in each wave (p-value for the interaction: number of teeth = 0.765; use of dental prostheses = 0.853; functional oral health = 0.806).

The association between periodontal pockets adjusted for other measures of dentition status and covariates was evaluated among dentate individuals (Table 4). These analyses included 1,883 observations from 1,149 individuals. Of them, 187 had three waves, 360 had two and 602 had one. The null model's intraclass correlation coefficient (ICC) showed that about 41% of the variation in the outcome was explained by between-individual differences. Gait speed was lower among individuals with attachment loss [-0.030 (-0.049; -0.010)]. BMI adjustment did not affect the magnitude of the association between attachment loss and gait speed. No interaction was found between periodontal pocket and time (p-value for the interaction term 0.436) and between attachment loss and time (p-value for the interaction term 0.350).

In the supplemental analyses for the total sample, using data from 2010 to 2015 (Supplementary Table 1), the effect of oral health measures did not attenuate after adjustment for the biomarkers (i.e., C-Reactive Protein and Albumin) and BMI. In the adjusted model, the number of teeth and the use of dental prostheses were positively associated with gait speed. Older adults with 1–10, 11–19 or 20+teeth had 0.020 m/s, 0.044 m/s and 0.039 m/s higher gait speed than edentulous. Individuals with poor functional oral health had on average lower gait speed. Among dentate individuals (Supplementary Table 2), older adults with periodontal pockets and attachment loss had lower gait speed than those without (-0.027 [95% CI -0.049; -0.006] and −0.026 [95% CI -0.047; -0.005], respectively).

Discussion

This study evaluated the longitudinal association between dentition status and gait speed in older adults. Our findings suggest a negative association between impaired dentition status and gait speed which was constant over time.

In our study, associations were more consistently found in the full sample (dentate plus edentate) than in the dentate sample. The use of dental prostheses and poor functional dentition were not associated with gait speed in the dentate sample. This might be related to the composition of the full sample, which had a higher proportion of edentulous individuals. However, this finding highlights that complete tooth loss is the worst dentition status for an individual and emphasizes the added value of complete removable dentures for edentate adults.

Similar to the current findings, among individuals 60 and older participating in the English Longitudinal Study of Aging (ELSA), edentulous individuals were slower than dentate ones. However, no association was found for incident reduced walking speed [32]. In the stratified analyses the association was significant only among those aged 60–74 years [32]. On the contrary, among Japanese older adults, aged 79–81 years, the posterior occlusal support was associated with the incidence of a reduced walking speed [33]. Kimble et al. [34] evaluated

Table 1 Distribution of the sample according to the study variables in each wave (unweighted estimates)

	Wave 2 (2006) (*n* = 1165)	Wave 3 (2010) (*n* = 1129)	Wave 4 (2015) (*n* = 1012)
	% (95% CI)	**% (95% CI)**	**% (95% CI)**
Age (mean, SD)	73.0 (8.8)	72.2 (9.2)	70.3 (8.1)
Sex			
Male	37.9 (35.2; 40.8)	36.1 (33.4; 39.0)	35.0 (32.1; 38.0)
Female	62.1 (59.2; 64.8)	63.9 (61.0; 66.6)	65.0 (62.0; 67.9)
Schooling (mean, SD)	4.2 (4.0)	4.8 (4.1)	6.1 (4.7)
Smoke			
No	54.7 (51.8; 57.5)	51.9 (49.0; 54.8)	49.9 (46.8; 53.0)
Yes	10.5 (8.8; 12.4)	10.9 (9.2; 12.9)	12.6 (10.7; 14.8)
Former	34.8 (32.2; 37.6)	37.2 (34.4; 40.1)	37.5 (34.5; 40.5)
Alcohol			
No	72.4 (69.8; 74.9)	70.5 (67.8; 73.1)	69.5 (66.6; 72.2)
Yes, no risk	22.5 (20.2; 25.0)	26.5 (24.0; 29.1)	28.6 (25.9; 31.4)
Yes, with risk	5.1 (3.9; 6.5)	3.0 (2.2; 4.2)	2.0 (1.3; 3.0)
Physical activity			
No	42.3 (39.5; 45.2)	60.7 (57.8; 63.5)	58.4 (55.3; 61.4)
Yes	57.7 (54.8; 60.5)	39.3 (36.5; 42.2)	41.6 (38.6; 44.7)
Hypertension			
No	36.5 (33.8; 39.3)	30.5 (27.9; 33.2)	30.9 (28.2; 33.8)
Yes	63.5 (60.7; 66.2)	69.5 (66.8; 72.1)	69.1 (66.2; 71.8)
Diabetes			
No	80.5 (78.1; 82.7)	73.2 (70.5; 75.7)	70.5 (67.6; 73.2)
Yes	19.5 (17.3; 21.9)	26.8 (24.3; 29.5)	29.5 (26.8; 32.4)
Cardiovascular disease			
No	76.5 (74.0; 78.8)	74.0 (71.3; 76.4)	73.5 (70.7; 76.1)
Yes	23.5 (21.2; 26.0)	26.0 (23.6; 28.7)	26.5 (23.9; 29.3)
Stroke			
No	92.6 (91.0; 94.0)	92.4 (90.7; 93.8)	93.9 (92.2; 95.2)
Yes	7.4 (6.0; 9.0)	7.6 (6.2; 9.3)	6.1 (4.8; 7.8)
Cognitive performance (mean, SD)	15.8 (3.7)	16.1 (3.3)	16.0 (3.0)
BMI (mean, SD)	26.5 (5.0)	28.1 (5.2)	28.5 (5.4)
Gait speed (mean, SD)	0.75 (0.29)	0.76 (0.23)	0.74 (0.21)
Number of teeth			
0	50.2 (47.3; 53.1)	42.6 (39.7; 45.5)	35.3 (32.4; 38.3)
1–10	24.1 (21.7; 26.7)	24.8 (22.4; 27.4)	26.2 (23.6; 29.0)
11–19	12.3 (10.5; 14.3)	15.1 (13.1; 17.3)	17.5 (15.3; 20.0)
20+	13.4 (11.6; 15.5)	17.5 (15.4; 19.9)	21.0 (18.6; 23.7)
Use of dental prostheses			
No	18.3 (16.2; 20.6)	21.1 (18.8; 23.6)	21.8 (19.4; 24.5)
Yes	81.7 (79.4; 83.8)	78.9 (76.4; 81.2)	78.2 (75.5; 80.6)
Periodontal pocket*			
No	82.6 (79.3; 5.5)	63.1 (59.3; 66.8)	54.0 (50.2; 57.8)
Yes	17.4 (14.5; 20.7)	36.9 (33.2; 40.7)	46.0 (42.2; 49.8)
Attachment loss*			
No	35.3 (31.6; 39.3)	43.8 (40.0; 47.7)	42.0 (38.3; 45.8)
Yes	64.7 (60.7; 68.4)	56.2 (52.3; 60.0)	58.0 (54.2; 61.7)
Poor Functional oral health			
No	66.2 (63.4; 68.8)	67.4 (64.6; 70.1)	76.9 (74.2; 79.4)
Yes	33.8 (31.2; 36.6)	32.6 (29.9; 35.4)	23.1 (20.6; 25.8)

*Estimation for dentate individuals

Table 2 Gait speed by oral health measures for the total sample

	Wave 2 (2006)		Wave 3 (2010)		Wave 4 (2015)	
	Mean (SD)		Mean (SD)		Mean (SD)	
Number of teeth						
0 (reference)	0.70	(0.29)	0.69	(0.23)	0.68	(0.21)
1–10	0.76**	(0.26)	0.78***	(0.23)	0.74***	(0.21)
11–19	0.82***	(0.28)	0.81***	(0.22)	0.79***	(0.21)
20+	0.87***	(0.30)	0.86***	(0.21)	0.81***	(0.20)
Use of dental prostheses						
No	0.78	(0.30)	0.78	(0.23)	0.77	(0.22)
Yes	0.75	(0.29)	0.76	(0.24)	0.73*	(0.21)
Periodontal pocket†						
No	0.81	(0.28)	0.81	(0.23)	0.78	(0.22)
Yes	0.79	(0.26)	0.81	(0.22)	0.78	(0.19)
Attachment loss†						
No	0.82	(0.25)	0.83	(0.24)	0.78	(0.21)
Yes	0.80	(0.29)	0.79*	(0.22)	0.77	(0.21)
Poor functional oral health						
No	0.78	(0.29)	0.79	(0.23)	0.75	(0.21)
Yes	0.71**	(0.28)	0.69***	(0.24)	0.71*	(0.21)

†Estimation for dentate individuals

*$p<0.05$, **$p<0.01$, $p<0.001$

Table 3 Longitudinal association between oral health and gait speed for the total sample (3,306 observations from 1,964 individuals)

Fixed effects	**Model 1**	**Model 2**	**Model 3**	**Model 4**
	Coef. (95%CI)	**Coef. (95%CI)**	**Coef. (95%CI)**	**Coef. (95%CI)**
Number of teeth (ref. = 0)				
1–10		0.071*** (0.048; 0.093)	0.021* (0.001; 0.041)	0.023* (0.003; 0.043)
11–19		0.118*** (0.092; 0.144)	0.051*** (0.026; 0.075)	0.053*** (0.028; 0.078)
20+		0.151*** (0.126; 0.176)	0.047** (0.019; 0.075)	0.047* (0.019; 0.075)
Use of dental prostheses (ref. = no)				
Yes		-0.032** (-0.054; -0.010)	0.026* (0.004; 0.048)	0.024* (0.002; 0.046)
Poor functional oral health (ref. = no)				
Yes		-0.053*** (-0.071; -0.036)	-0.019* (-0.035; -0.004)	-0.020* (-0.036; -0.004)
Time		-0.006*** (-0.008; -0.004)	-0.011 *** (-0.013; -0.009)	-0.011*** (-0.013; -0.009)
Random effects				
Time slope variance	0.000 (0.000; 0.001)		0.000 (0.000; 0.001)	0.000 (0.000; 0.001)
Time intercept variance	0.025 (0.022; 0.029)		0.016 (0.014; 0.019)	0.015 (0.013; 0.018)
Covariance slope-intercept	-0.002 (-0.003; -0.002)		-0.002 (-0.002; -0.001)	-0.002 (-0.002; -0.001)
Residual variance	0.032 (0.029; 0.035)		0.026 (0.024; 0.029)	0.027 (0.024; 0.029)
ICC†	0.443 (0.394; 0.494)			

*$p<0.05$, **$p<0.01$, $p<0.001$

†Intraclass Correlation Coefficient

Model 1 = Null model

Model 2 = unadjusted

Model 3 - Model adjusted for age at baseline and time-varying covariates (sex, schooling, hypertension, diabetes, cardiovascular, disease, stroke, smoke, alcohol, physical activity, cognitive performance)

Model 4 = Model 3 + time-varying BMI

this association in two cohort studies of older adults (aged 70 years or older), including men from the British Regional Heart Study (BRHS), and men and women from the Health, Aging and Body Composition (Health ABC) in the USA. The presence of periodontal pocket was the only baseline oral health measure associated with incident reduced gait speed at the BRHS. In both cohorts, changes in dentition status between baseline and follow-up were not associated with incident reduced gait speed. On the other hand, among older adults (60 and older) from the Swedish National Study on Aging and Care in Kungsholmen (SNAC-K) [31] a significant interaction between baseline tooth loss (a combination of own teeth

Table 4 Longitudinal association between oral health and gait speed among individuals with teeth (1,883 observations from 1,149 individuals)

Fixed effects	Model 1	Model 2	Model 3	Model 4
	Coef. (95%CI)	**Coef. (95%CI)**	**Coef. (95%CI)**	**Coef. (95%CI)**
Number of teeth (ref. = 1–10)				
11–19		0.047** (0.019; 0.074)	0.035** (0.009; 0.061)	0.035** (0.009; 0.062)
20+		0.080*** (0.053; 0.107)	0.031* (0.001; 0.060)	0.029 (-0.001; 0.058)
Use of dental prostheses (ref. = no)				
Yes		-0.007 (-0.031; 0.017)	0.021 (-0.003; 0.046)	0.020 (-0.004; 0.045)
Poor Functional oral health (ref. = no)				
Yes		-0.050*** (-0.074; -0.027)	-0.021 (-0.042; 0.001)	-0.021 (-0.043; 0.000)
Periodontal pocket (ref. = no)				
Yes		-0.008 (-0.030; 0.013)		
Attachment loss (ref. = no)		-0.025* (-0.046; -0.004)	-0.030** (-0.050; -0.010)	-0.030** (-0.049; -0.010)
Yes				
Time		-0.007*** (-0.010; -0.004)	-0.010*** (-0.013; -0.007)	-0.010*** (-0.013; -0.007)
Random effects				
Time slope variance	0.000*** (0.000; 0.001)		0.000 (0.004; 0.012)	0.000 (0.000; 0.001)
Time intercept variance	0.022** (0.018; 0.026)		0.015 (0.012; 0.019)	0.015 (0.012; 0.018)
Covariance slope-intercept	-0.002*** (-0.002; -0.001)		-0.001 (-0.002; -0.001)	-0.001 (0.002; -0.001)
Residual variance	0.032** (0.028; 0.036)		0.027 (0.024; 0.031)	0.027 (0.024; 0.031)
ICC†	0.405 (0.340; 0.474)			

*$p < 0.05$, **$p < 0.01$, $p < 0.001$

†Intraclass Correlation Coefficient

Model 1 = null model

Model 2 - unadjusted

Model 3 = Model adjusted for age at baseline and time-varying covariates (sex, schooling, hypertension, diabetes, cardiovascular disease, stroke, smoke, alcohol, physical activity, cognitive performance)

Model 4 = Model 3 + BMI

with the use of dental prostheses) and time was observed [31].

The mechanism underlying the association between clinical oral health measures and gait speed remains elusive. The lack of interaction between dentition status and time in the present study suggests that the effect of oral health on gait speed may be more related to long-term than immediate changes. This prompts further exploration into potential mediating pathways such as the role of balance, nutritional factors, or other unexplored variables that have been deemed as both the consequence of impaired oral health [17, 28, 48] and the contributing factors to a reduced gait speed [28, 49–51]. In addition, the negative effect on gait speed found for clinical attachment loss but not periodontal pockets underscores potential long-term influences. This is because clinical attachment loss is a cumulative measure of disease whereas periodontal pocketing reflects active current disease. There is a need to further explore the previously reported inflammatory pathway [31]. Further studies should explore the severity of periodontal conditions and specific biomarkers of inflammation.

In our study, there were no changes in the magnitude of the associations for all dentition status coefficients after adjustment for CRP. This finding corroborates the ones from Kimble et al., using plasma concentration of Il-6 [34], and Tsakos et al., using CRP, although the latter only had information for self-reported edentulism [32]. Unlike this, Welmer et al. found that the gradient difference in walking speed decline by baseline tooth loss status was attenuated and no longer significant after adjusting for CRP. However, as the authors pointed out, the association remains inconclusive since the differences in point estimates for the groups did not differ much between the model adjusted for CRP and the model without adjustment for CRP [31]. Although, most of the studies did not assess periodontal conditions they suggested that denture stomatitis [32] and tooth loss [31] could be sources of oral inflammation. In the case of tooth loss, the authors argued that it is an indirect marker of previous and current periodontal disease [31]. Concerning the present study, it is also worth noting that the prevalence of severe tooth loss in our sample is high, limiting the evaluation of periodontal disease.

We have identified several strengths in our study, including its longitudinal design which enables us to examine associations over time, and our use of a comprehensive set of clinical and self-reported measures of dentition status and covariates. However, we also acknowledge some limitations, such as the potential for unmeasured confounders. Additionally, relying on a single biomarker and the lack of diet and nutritional information limited our ability to explore the mechanism connecting oral health and gait speed in more detail.

In summary, our research provides valuable insights into the complex relationship between dental health and gait speed among older adults. The observed enduring association challenges assumptions about the predictability of longitudinal variations, emphasizing the need for further research. Comparisons with existing longitudinal studies, particularly those employing clinical oral health measures, highlight both shared and divergent insights, paving the way for a deeper understanding of the mechanisms and implications of clinical oral health on physical function in older adults. Further studies are needed to explore these associations and to define the magnitude of the declines that have clinical significance. Understanding the clinical implications of these declines is crucial for developing targeted interventions and improving patient outcomes.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12877-024-05325-2.

Supplementary Material 1

Author contributions

FBA: Conceptualization, Writing - Original Draft, reviewing and editing, formal analysis, interpretation of findings. RLF: formal analysis, Writing - Review and editing, interpretation of findings. YAOD: Data Curation, Writing - Review and editing, interpretation of findings. CO: Writing - Review and editing, interpretation of findings. WS: Writing - Review and editing, interpretation of findings. EB: Writing - Review and editing, interpretation of findings. JLFS: Data Curation, Writing - Review and editing, interpretation of findings.

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Data availability

Access to the data can be granted upon submitting a reasonable request to the SABE's Principal Investigator, Dr. Yeda Aparecida de Oliveira Duarte.

Declarations

Ethics approval and consent to participate

The SABE study was approved by the Ethics in Research Committee of the School of Public Health of the University of São Paulo. Written informed consent from all the participants was obtained at each interview.

Consent for publication

Not Applicable.

Competing interests

The authors declare no competing interests.

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