

Relationship Between Tooth Loss and Sarcopenia in Chinese Suburban Community-dwelling Older Adults

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Abstract

Background: Both sarcopenia and loss of teeth are associated with aging. The purpose of this study was to investigate potential relationships between tooth loss and sarcopenia and components of sarcopenia, including declining muscle mass, muscle strength, and physical performance, in Chinese suburban community-dwelling older adults.

Methods: The subjects were 1494 people over 60 years of age (average age: 71.64 ± 5.97 years—men, $n=609$) from Chongming District of Shanghai and Hangu District of Tianjin. The Asian Working Group for Sarcopenia (AWGS) criteria were used to define sarcopenia. The three basic diagnostic components of sarcopenia (muscle mass, muscle strength, and physical performance) were assessed using a bioelectrical impedance analyzer, a grip strength test, and a four-meter walk test, respectively. The subjects were divided into groups depending on self-reported loss of teeth.

Results: After adjusting for confounding variables, we found no correlation between tooth loss and sarcopenia or muscle mass. However, the walking speed of female participants with at least 10 teeth lost was 0.059 m/s slower than that of participants with fewer than 10 teeth lost ($P=0.001$), and grip strength was 1.577 kg lower among male participants with at least 10 teeth lost than among males with fewer than 10 teeth lost ($P=0.023$).

Conclusion: Our results suggest that tooth loss is negatively correlated with muscle strength in males and average walking speed in females. These results are consistent with the importance of good oral hygiene in preventing declines of physical performance in older adults.

Introduction

China's aging problem is becoming increasingly serious, with 164.5 million people aged 65 and above^[1]. At the same time, incidence of age-related sarcopenia is also on the rise, and it has become an important focus of geriatric research. Sarcopenia is defined as the age-related loss of indicators of skeletal muscle quality, including muscle mass, strength and physical performance. In older adults, sarcopenia is associated with an increase in adverse outcomes, including falls, functional decline, weakness and death^[2, 3]; therefore, active prevention and treatment of sarcopenia is particularly important.

The older adults also face increasingly serious problems with oral health associated with declines of physical and mental health. Oral health problems can have a significant impact on the elderly, leading to discomfort, pain and tooth loss. Tooth loss, in particular, is an indicator of poor oral health^[4], and the number of missing teeth may reflect the cumulative level of oral inflammation^[5]. In addition, the local inflammation caused by tooth loss can induce a systemic inflammatory response^[6]. These systemic changes, such as changes in serum levels of the inflammatory biomarkers C-reactive protein and interleukin, also occur in muscle injury. The inflammation associated with poor oral health may, then, affect physical fitness, especially muscle mass, muscle strength and muscle function^[7]. In addition, adult tooth loss may affect physical fitness and contribute to sarcopenia by reducing diet quality and the intake of nutrients^[8]. Therefore, it is reasonable to think that tooth loss is causally related to sarcopenia and its components.

In a recent study, poor oral health, including tooth loss, was shown to be a predictor of future sarcopenia in community-dwelling older adults^[9], while two other studies identified tooth loss as a risk factor for sarcopenia in adults^[10, 11]. Despite the significant correlations that have been identified, there are relatively few studies on tooth loss and sarcopenia, and those that have been performed typically did not evaluate denture status, which has been shown to impact nutritional status^[12]. Therefore, it is necessary to establish whether tooth loss is a risk factor for sarcopenia in the elderly. In addition, the relationship between tooth loss and muscle mass, strength and function, which are indicators of sarcopenia, remains controversial^[13-18]. There are also few comprehensive studies on tooth loss relative to the specific components of sarcopenia, muscle mass, muscle strength, and physical performance.

Here, we conducted a cross-sectional study to determine the relationship between tooth loss and sarcopenia and its contributing factors among Chinese suburban community-dwelling older adults, so as to provide a reference for predicting decreased physical performance and identifying high-risk groups. Given the ease with which oral health interventions can be integrated into daily life, it is important to determine whether such interventions can be used to reduce age-related risks of sarcopenia and decline of physical performance.

Materials And Methods

Study participants

Our study population included residents from Hangu District, Tianjin and Chongming District, Shanghai, China. Participants were selected from 1614 individuals of age 60 years or above in these areas who joined the national free physical examination program conducted from August 2018 and June to July 2019. Participants with the following conditions were excluded from the study: (1) inability to communicate with interviewers or to grant informed consent; (2) inability to perform the handgrip strength test or the 4 m walking test; (3) failure to complete body composition measurement; or (4) failure to complete the questionnaire about oral care. The final study population comprised 1494 subjects. This research was approved by the Ethics Committee at Tianjin Medical University and Shanghai University of Medicine and Health Sciences, and informed consent was obtained from all patients.

Assessment of the number of teeth

Participants arriving at community health service centers submitted a questionnaire via a face-to-face interview. Tooth status was assessed via a self-reported measure that asked participants about number of teeth lost. Possible answers were none, 1, 2, from 3 to 5, from 6 to 9, and 10 or more. Participants were then categorized into two groups based on the number of teeth missing: from 0 to 9 teeth lost or 10 or more teeth lost. Participants also self-reported denture status.

Assessment of sarcopenia

We used the definition from the Asian Working Group for Sarcopenia to assess sarcopenia^[19]. Here, a person with low muscle mass, low muscle strength and/or low physical performance was identified as having sarcopenia. Low muscle mass was defined as a relative skeletal muscle mass index, which is the ratio of appendicular skeletal muscle mass (ASM) to height (Ht)², of less than 7.0 kg/m² in men and 5.7 kg/m² in

women. Low physical performance was defined as an average walking speed of less than or equal to 0.8 m/s. Low muscle strength was defined as a grip pressure of less than 26 kg for men and less than 18 kg for women. ASM values were obtained using a bioelectrical impedance analyzer (Inbody720; Bio space Co., Ltd, Seoul, Korea).

Assessment of muscle strength

Muscle strength was assessed via average grip strength of two attempts at maximum effort with a participant's dominant hand. Grip strength was measured using a dynamometer (Grip-D; Takei Ltd, Niigata, Japan).

Assessment of physical performance

Walking speed was used as a marker of physical performance. To measure walking speed, we placed two photocells connected to a recording timer at the beginning and end of a 4 m course on site. Participants were asked to stand with their feet touching the starting line. When the tester gave the "start" command, participants began to walk at a normal speed, and the time between the activation of the first and second photocells was recorded.

Assessment of covariates

Sociodemographic and behavioral characteristics and medical conditions were obtained from the participants through face-to-face consultations and questionnaires. Sociodemographic variables, including age, gender, marital status and educational level were assessed. Weight and height were measured, and body mass index (kg/m^2) was calculated. Marital status was categorized as widowed or not. Living conditions were divided into living alone or not. The level of education was divided into literate and illiterate. Behavioral characteristics included information on smoking (never, former smoker, or current smoker) and drinking (never, former drinker, occasional or daily drinker) habits and were obtained from the questionnaire. Family annual income was also included, and categories were less than 1000 yuan, 1000-3000 yuan, 3000 to 5000 yuan, and greater than 5000 yuan. The presence of specific medical conditions, including diabetes, hypertension, dyslipidemia, were established using standardized criteria that combined information from history of physical illness evaluated on the basis of participants' responses to questions, physician diagnoses, and statuses of corresponding treatments, pharmacological or otherwise. Denture status was divided into two groups: those with partial dentures and full dentures, and those without dentures. The short form of the International Physical Activity Questionnaire (IPAQ) was used to evaluate physical activity^[20]. The Geriatric Depression Scale (GDS) was used to assess depressive symptoms in older adults; a GDS score of at least 11 was defined as depression^[21]. We assessed nutritional status with Mini Nutritional Assessment (MNA) scores^[22].

Statistical analyses

We separated the participants by sex and classified the number of teeth lost into two groups (0 to 9 and at least 10). Analysis of variance (ANOVA) and chi-square tests were conducted to compare the characteristics and lifestyle habits of individuals between the two groups. Binary logistic regression models and multivariate linear regression models were used for modelling the relationships among the three basic diagnostic components of sarcopenia and the number of teeth lost. Model 1 controlled for the covariates age and BMI; Model 2 was based on model 1, with additional adjustments of IPAQ results, income, literacy, smoking, drinking and denture status;

Model 3 was based on model 2, with additional adjustments of depression, nutrition status, hypertension and diabetes. Bilateral $P < 0.05$ was considered to be statistically significant. All statistical analyses were performed using IBM SPSS Statistics 25.0.

Results

The data of 1614 participants from Hangu District, Tianjin and Chongming District, Shanghai were collected in August 2018 and June to July 2019. A total of 1494 participants were included for analysis in this study. Table 1 and Table 2 show the socioeconomic characteristics, demographics and disease statuses of the participants. Of the participants, 609 (40.7%) were male. It was found that age, BMI, relative skeletal muscle mass index, grip strength, average walking speed, overall sarcopenia status, and denture status were significantly different between the groups that were categorized according to the number of teeth lost (Table 1 and Table 2).

A binary logistic regression model was applied, and the data were adjusted for the covariates age, BMI, district of residency, IPAQ results, income, literacy, smoking and drinking practice, denture status, depression, nutrition score, hypertension, and diabetes. We did not identify a statistical relationship between tooth loss and sarcopenia (Table 3). Next, a multivariate linear regression model was developed, after adjusting for the potentially confounding factors. In this analysis, muscle mass was not associated with tooth loss in either sex group. In men, grip strength was 1.577 kg lower in those with at least 10 teeth lost as compared with those with nine or fewer teeth lost ($P = 0.023$). Among women, participants who had lost at least 10 teeth had an average walking speed that was 0.059 m/s slower than that of participants with nine or fewer teeth lost ($P < 0.001$) (Table 4).

Discussion

Our research examined associations between self-reported tooth loss and sarcopenia and its components (muscle mass, muscle strength, and physical performance) in Chinese suburban community-dwelling older adults after adjusting for various confounders. Considering that the association between the number of teeth and physical performance remains controversial, the results of this representative study are important.

The relationship between tooth loss and sarcopenia

Our study disagrees with previous research that has linked general sarcopenia to oral health. In one recent study, subjects with fewer than 20 natural teeth had an adjusted odds ratio for sarcopenia of 1.96 for men and 2.86 for women, compared with those with full dentition^[10]. Another cross-sectional study also showed that impaired dentition was significantly associated with sarcopenia in Japanese adults living in the community^[11]. In a meta-analysis of 27 studies reviewed, a possible association between oral health status and sarcopenia was found; however, most of the studies included in this analysis were cross-sectional studies in Japan, and the results therefore are not representative^[23].

On the other hand, after adjusting for covariate factors, we found no association between tooth loss and sarcopenia in either sex. One possible explanation for the disagreement may result from the varying ages of study participants. Age is an important factor in sarcopenia: physical function declines by approximately 4% every year after the age of 65, and movement disorders become more common, affecting 24% of adults over 75

years old^[24, 25]. We used relatively young older adults, and the age range of the population included in our study fairly small; male and female study participants were aged, on average, 71.94±5.97 years and 71.44±5.97 years, respectively. In other studies, either the ages of participants exceeded 75 years or the range of ages of inclusion was too wide to permit generalizable claims^[10, 11]. These differences in participant ages, then, may explain why other groups found relationships between tooth loss and sarcopenia, even though no such relationships seem to exist in age-matched groups. Notably, thus far, associations between tooth loss and sarcopenia have been reported only rarely, and no firm conclusions have been drawn. Further large longitudinal studies are needed to test these proposed relationships.

The relationship between tooth loss and muscle mass

While connections between sarcopenia in general and tooth loss are controversial, more detailed studies have suggested that links between tooth loss and one component of sarcopenia, low muscle mass, may occur through inflammatory and nutritional pathways^[26, 27]. For example, one key factor in tooth loss, periodontitis, increases levels of interleukin-6 and tumor necrosis factor-alpha in gingival tissue. Resultant systemic increases of these inflammatory cytokines can cause loss of muscle mass^[28, 29]. In support of this mechanistic connection, Akinari et al found that tooth loss was an independent risk factor for decreased muscle mass in men but not in women^[18]. Notably, there are limitations to this study, especially regarding the relatively small sample size.

In a recent longitudinal study, poor oral health, including tooth loss, was shown to be a predictor of future muscle loss in older people living in the community^[9]. A Korean study similarly showed that participants with at least 20 remaining natural teeth had more muscle mass on average than those with fewer than 20 remaining natural teeth. While this latter study ostensibly demonstrated a connection in men and women, after correcting for confounding factors, the number of remaining teeth and muscle mass were found to correlate in men but not in women over age 65^[30]. It is speculated that the reason for gender differences in this correlation may be that men and women tend to make different food choices, with women tending to eat more fruits and vegetables than men. This lifestyle connection may lead to a limiting of protein intake in women and thus gender-related differences in muscle mass dynamics.

Our findings are inconsistent with several previous studies, however. Although we did identify differences in muscle mass between men and women, after adjusting for confounders, we found no correlation between tooth loss and muscle mass. One reason for these differences may involve the assessment tool. We used a reliable method that is specified by Asian Working Group for Sarcopenia^[19], and this method would be expected to lead to highly accurate results. In addition, our study population lives in the suburban community, and many of the participants were of low economic status and had been engaged in agricultural labor during their working years. These physical factors could have influenced muscle development and the impact of inflammatory factors arising from gingivitis.

The relationship between tooth loss and grip strength

Grip strength is a commonly used indicator of total body strength and is a known predictor of disability and mortality^[31]. A recent Chinese study showed no link between tooth loss and grip strength in people over the age

of 60^[32]. In a Japanese community study involving participants ages 40 to 70, there was also no correlation found between the number of teeth and grip strength in either sex^[18]. The results of this latter study are limited because of the lack of consideration of confounding factors, including socioeconomic status and the use of dentures, both of which have clear connections to tooth loss. In particular, the use of dentures can improve the chewing ability of older adults and thus can improve nutrient intake and nutritional status, which would affect physical performance and muscle strength^[33].

On the other hand, in a South Korean study, while associations between the number of teeth and grip strength disappeared entirely in women after adjusting for socioeconomic status, use of dentures, health behavioral factors and general health, statistically significant connections remained in men^[14]. Hamalainen et al also found a positive correlation between the number of teeth and grip strength in men over the age of 80, but found no correlation in women^[17]. A recent study similarly reported an association between tooth loss and mortality in older men, but not in women^[34]. These findings are consistent with the results of our present study.

The differences in associations between men and women are difficult to explain. Variabilities in socioeconomic factors and social activity may be important influences on differences between men and women, and these factors may explain the lack of association between tooth loss and grip strength in women. In addition, reported results are not directly comparable, since there were differences in age distribution, methods of measuring grip strength, and adjustment for confounding factors in the previous studies^[14, 17, 18, 32]. Therefore, gender differences in the relationship between the number of teeth and grip strength is intriguing and deserves further study.

The relationship between tooth loss and walking speed

Walking speed is a clinically useful indicator of mobility and overall health status in older adults and an independent predictor of adverse outcomes such as disability and mortality^[35, 36]. Decreases in walking speed likely result from a variety of factors that occur throughout life. Previous studies have confirmed that tooth loss is associated with slower average walking speed^[37]. In addition, circulation levels of biomarkers of inflammation have been shown to be negatively associated with walking speed^[38]. The mechanism of association can be explained in that an elevated level of proinflammatory cytokines in the serum of patients with periodontal disease may change the metabolism within local muscles groups leading to a decline in physical performance^[39]. Accordingly, a recent cohort study showed that tooth loss was associated with an accelerated decline in walking speed in older adults, inflammation may play a role in the association between tooth loss and walking speed decline^[40]. However, the population included in this study had a higher education, and the results may not be applicable to older suburban-dwelling adults with lower literacy rates.

Our study found that even after adjustment for confounding variables, tooth loss was associated with walking speed in women, but not in men. Our results are similar to a study from Japan^[18]. Men, therefore, seem to be less prone to age-related bone and muscle decline than are postmenopausal women. While sex steroids can stimulate peak bone and muscle mass growth in adolescence and middle age, and prevent subsequent loss in older men, they have no effect on postmenopausal women^[41]. Women are particularly vulnerable to decreased walking speed because of the dramatic decline in estrogen levels after menopause^[42]. Men, conversely, tend to have enough muscle in their lower limbs to overcome the high rate of decrease of muscle mass with age^[18].

These factors may explain our result that tooth loss was significantly related to walking speed in women, but not in men. Preventing tooth loss, then, may be more important for women.

Strength And Limitations

Some limitations of this study are worth mentioning. First, measurement of oral health status was based on self-reports, not clinical examination. However, the validity and reliability of self-reported oral health has been established by multiple studies, and this method is widely used in epidemiological surveys. Secondly, this study is a cross-sectional study and is not a study of causal relationships between tooth loss and sarcopenia and its components; causal relationships should be addressed in future longitudinal studies. Finally, some older adults with poor physical performance may have been excluded from the study because it was not convenient for them to leave home to participate in a physical examination. The participants in this study are therefore older adults with good activity levels, and this self-selection may have an impact on the research results.

This study also has many strengths. First, for older adults, reducing tooth loss can improve functioning and reduce risks associated with physical decline. This result informs us that caregivers or individuals can prevent or reduce physical performance decline by improving oral health. Second, the study provided additional data regarding the oral health of a suburban community-dwelling population, and it therefore fills an important gap in understanding.

Conclusions

Our research found that tooth loss is not related to sarcopenia and muscle mass, but tooth loss is related to physical performance and muscle strength. These associations provide the possibility of improving the physical function of the older adults by improving oral health. The factors identified in this study can be used in suburban community health plans to maintain the physical function of older adults.

Declarations

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Abbreviations

BMI, body mass index; ASM/Ht^2 , ASM, appendicular lean mass; Ht, Height; IPAQ, International Physical Activity Questionnaire; MET/week, metabolic equivalent task minutes per week.

Availability of data and materials

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics approval and consent to participate

This study was approved by the Shanghai University of Medicine and Health Sciences ethics committee. All participants signed an informed consent form to participate before data collection.

Competing interests

The authors declare that they have no competing interests.

Consent for publication

Written informed consent for publication was obtained from all participants.

Authors' contributions

Feng Wang and Jingru Wang were major contributor in writing the manuscript and contributed to the statistical analysis. Peipei Han and Yuewen Liu contributed to guide the statistical analysis. Weibo Ma, Hui Zhang, Ning Wu, Sijia Sang, Yining Xia, Jiangtao Pan, Fandi Xie, Shumeng Niu, Hao Hu, Hongbing Wang and Yang Liu contributed to the conception or design of the work and data collection. Ying Yu and Qi Guo guided the other authors in data analysis. Qi Guo directed the revision of the manuscript. All authors read and approved the final manuscript.

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Tables

Table1 Characteristics of male study group, stratified by number of tooth loss			
Variable	Number of tooth loss		p
	0 to 9	≥10	
	(n=335)	(n=274)	
Age(y)	70.07±5.26	74.23±6.00	∅0.001
BMI	24.25±3.03	22.93±3.54	∅0.001
ASM/Ht ² (kg/m ²)	7.86±0.97	7.51±0.79	∅0.001
Grip strength (kg)	31.13±7.44	27.57±7.78	∅0.001
Walk speed (m/s)	1.14±0.24	1.07±0.25	0.001
IPAQ (Met/week)	4164(1533,8400)	3786(1626,6426)	0.033
Widowed, n (%)	25(7.5)	33(12.0)	0.057
Living alone, n (%)	36(10.7)	33(12.0)	0.615
Illiteracy	22(6.6)	27(9.9)	0.251
Income∅n (%)			0.363
∅1000	49(14.7)	40(14.7)	
Smoking, n (%)			∅0.001
Current smokers\	92(27.5)	111(40.7)	
Drinking, n (%)			0.003
Daily drinkers	78(23.6)	78(29.0)	
Nutritional status			0.014
well-nourished	272(81.2)	195(71.2)	
at risk of malnutrition	61(18.2)	76(27.7)	
malnourished	2(0.6)	3(1.1)	
Disease∅n (%)			
Hypertension	223(66.6)	171(62.4)	0.285
hypercholesterolemia	204(60.9)	139(50.7)	0.012
Diabetes	54(16.1)	53(19.3)	0.298
Stoke	26(7.8)	22(8.1)	0.897
Sarcopenia	19(5.7)	40(14.6)	∅0.001
Depression	32(9.8)	27(9.9)	0.954
Cognitive impairment	38(11.8)	40(15.2)	0.241

Brushing frequency, n (%)			0.161
≥2 time /day	113(33.7)	78(28.4)	
≠2 time /day	222(66.3)	196(71.6)	
Brushing time, n (%)			0.616
≠2min	181(53.9)	153(56.0)	
≥2min	154(46.1)	121(44.0)	
Gingival bleeding, n (%)	44(13.2)	14(5.2)	0.001
Denture status, n (%)	86(25.7)	184(67.2)	≠0.001
Note: Data are shown as mean ± SD or number (percentage).			
Abbreviation: BMI, body mass index; ASM/Ht ² , ASM, appendicular lean mass; Ht, Height; .IPAQ, International Physical Activity Questionnaire; MET/week, metabolic equivalent task minutes per week;			

Table 2 Characteristics of female study group, stratified by number of tooth loss

Variable	Number of tooth loss		p
	0 to 9	≥10	
	(n=436)	(n=449)	
Age(y)	69.42±5.19	73.40±6.03	0.001
BMI	24.73±3.62	23.93±3.47	0.001
ASM/Ht ² (kg/m ²)	6.36±0.94	6.08±0.79	0.001
Grip strength (kg)	19.09±5.54	17.46±5.56	0.001
Walk speed (m/s)	1.08±0.17	0.99±0.23	0.001
IPAQ (Met/week)	4519(2373,8363)	4110(1688,8078)	0.643
Widowed, n (%)	91(20.9)	142(31.6)	0.001
Living alone, n (%)	60(13.8)	101(22.5)	0.001
Illiteracy	106(24.4)	110(24.5)	0.691
Income (n (%))			0.956
≤1000	93(21.3)	97(21.7)	
Smoking, n (%)			0.433
Current smokers\	27(6.2)	37(8.3)	
Drinking, n (%)			0.104
Daily drinkers	13(3.1)	24(5.4)	
Nutritional status			0.288
well-nourished	344(78.8)	340(75.8)	
at risk of malnutrition	91(21.0)	105(23.3)	
malnourished	1(0.2)	4(0.9)	
Disease (n (%))			
Hypertension	279(64.0)	316(70.4)	0.043
hypercholesterolemia	302(69.3)	319(71.0)	0.563
Diabetes	90(20.7)	84(18.8)	0.479
Stoke	20(4.7)	25(5.6)	0.528
Sarcopenia	43(9.9)	80(17.8)	0.001
Depression	54(12.6)	57(12.9)	0.881

Cognitive impairment	79(19.3)	103(24.5)	0.067
Brushing frequency, n (%)			0.862
≥2 time /day	192(44.0)	200(44.6)	
≠2 time /day	244(56.0)	249(55.4)	
Brushing time, n (%)			0.255
≠2min	268(61.5)	259(57.7)	
≥2min	168(38.5)	190(42.3)	
Gingival bleeding, n (%)	70(19.6)	45(10.5)	≠0.001
Denture status, n (%)	154(35.3)	333(74.2)	≠0.001
Note: Data are shown as mean ± SD or number (percentage).			
Abbreviation: BMI, body mass index; ASM/Ht ² , ASM, appendicular lean mass; Ht, Height; .IPAQ, International Physical Activity Questionnaire; MET/week, metabolic equivalent task minutes per week;			

Table3.Binary logistic regression of sarcopenia, showing effects as odds ratios and 95% confidence intervals						
Independent variable	Model 1		Model 2		Model 3	
	OR(95%CI)	p-value	OR(95%CI)	p-value	OR(95%CI)	p-value
Male						
0 to 9	Ref.		Ref.		Ref.	
≥10	1.369(0.703-2.665)	0.356	1.633(0.751-3.547)	0.216	1.585(0.696-3.231)	0.251
Female						
0 to 9	Ref.		Ref.		Ref.	
≥10	1.368(0.843-2.218)	0.205	1.242(0.727-2.123)	0.428	1.261(0.727-2.188)	0.409
Abbreviation: OR: odds ratio; CI: confidence interval.						
Note: Model 1: adjusted for Age, BMI, District. Model 2: adjusted for Age, BMI, District, IPAQ, Income, Illiteracy, Smoking, Drinking, Denture status. Model 3: adjusted for Age, BMI, District, IPAQ, Income, Illiteracy, Smoking, Drinking, Denture status, Depression, Nutrition status, Hypertension, Diabetes.						

Table 4. Linear association between the number of tooth loss and ASM/Ht² Grip strength Walk speed						
Independent variable	Model 1		Model 2		Model 3	
	β	p-value	β	p-value	β	p-value
ASM/(Ht)² (kg/m²)						
Male						
0 to 9	Ref.		Ref.		Ref.	
≥ 10	-0.066	0.289	-0.100	0.150	-0.083	0.212
Female						
0 to 9	Ref.		Ref.		Ref.	
≥ 10	-0.044	0.364	-0.011	0.830	-0.013	0.810
Grip strength (kg)						
Male						
0 to 9	Ref.		Ref.		Ref.	
≥ 10	-1.254	0.043	-1.707	0.013	-1.577	0.023
Female						
0 to 9	Ref.		Ref.		Ref.	
≥ 10	-0.614	0.112	0.797	0.055	-0.730	0.083
Walk speed (m/s)						
Male						
0 to 9	Ref.		Ref.		Ref.	
≥ 10	-0.029	0.149	-0.041	0.063	-0.036	0.107
Female						
0 to 9	Ref.		Ref.		Ref.	
≥ 10	-0.044	0.001	-0.063	≤ 0.001	-0.059	≤ 0.001
Note: Model 1: adjusted for Age, BMI, District. Model 2: adjusted for Age, BMI, District, IPAQ, Income, Illiteracy, Smoking, Drinking, Denture status. Model 3: adjusted for Age, BMI, District, IPAQ, Income, Illiteracy, Smoking, Drinking, Denture status, Depression, Nutrition status, Hypertension, Diabetes.						