2011 年のベースライン調査から 2014 年の追跡調査における IADL の低下は、会場調査群よりも未受診者調査群が大きいことが示された。分散分析の結果、群と調査時期の交互作用が有意であった（p<.001）。また、調査時期の主効果も有意であり、ベースライン時よりも追跡調査での IADL が低いことが示された（p<.05）。交互歳用に関する下位検定の結果、会場調査群ではベースラインと追跡の間の有意差がなかったが、追跡調査群では両者に有意な差がみられ、有意な低下が示された（p<.01）。

③精神的健康：精神的健康の指標である WHO5 の合計得点の平均値のベースライン調査と追跡調査の変化を群別に図 3 に示した。

2011 年のベースライン調査から 2014 年の追跡調査における WHO5 は、会場調査群では低下がみられないのに対して、未受診者調査群では低下がみられた。分散分析の結果、群と調査時期の交互作用が有意であった（p<.001）。その他、群の主効果も有意であり、会場調査群の精神的健康が高いことが示された（p<.001）。交互歳用に関する下位検定の結果、会場調査群ではベースラインと追跡の間の有意差がなかったが、追跡調査群では両者に有意な差がみられ、有意な低下が示された（p<.01）。

D．考察

1）未受診者調査による追跡率の向上について

本研究では、縦断研究の際に生じる脱落者を抑え、ベースライン調査の追跡率を向上させるため、2011 年に開始した 80 歳コホートの 2014 年度未受診者に対して訪問調査を実施した。その結果、追跡率は全地域を通じて 61%から 74%に向上した。

我々が行っている SONIC 研究のコホートは 80 歳代、90 歳代が主たる参加者であり、身体機能・知覚認知機能の低下から会場招待型調査は元より、より参加しやすい郵送調査や電話調査においても脱落する者が多くなると考えられる。今後も未受診者に対する訪問調査を活用し、追跡率・判明率の向上を図る必要がある。

2）会場招待型調査参加者と未受診者調査参加者の身体機能および精神的健康における 3 年間の変化の違いについて

昨年度の本報告書においては、2014 年度までに終了した未受診者訪問調査参加者と会場調査調査参加者の握力、手段的自立（IADL）、精神的健康の比較を行ったところ、身体機能について、握力では男性で訪問調査参加者がやや悪い傾向がみられ、手段的自立においては女性で得点の低い者が訪問調査参加者に有意に多い傾向がみられた。また、精神的健康においては、男女とも訪問調査参加者が会場調査参加者よりも有意に低いことが明らかになった。

本年度は、上記の結果を受け、全地域の未受診者調査データを用いて、2014 年度の追跡調査が会場調査参加者群と未受診者訪問調査参加者群において、ベースライン調

査からの３年間の変化を比較した。

その結果、男女込みの場合、①握力についてはベースライン調査時に両群間に有意差はなく、両群とも３年間に有意な変化はない。②手段的自立については、ベースライン調査時に未受診者調査群の方が会場調査群よりも有意にIADLが低く、また３年間で有意に大きく低下することが示された。③精神的健康については、ベースライン時に会場調査群、未受診者調査群の間に有意差がなかったものの、３年後の追跡調査時には未受診者調査群のみに低下がみられた。

これらの結果から、後期高齢者を対象としたIADLと精神的健康については、追跡調査時の脱落効果が示されたといえるだろう。様々な指標の縦断的変化を検討する上では、会場調査の結果のみで生じる脱落の効果を小さくするために、未受診者に対する訪問調査の結果を用いて検討を行うことの必要性が改めて示されたと言えるだろう。

今回の、調査結果からは、身体機能の指標である握力については、追跡可能者と脱落者の間に大きな差異はみられなかったが、生活機能に関する側面と心理的な側面に関しては脱落者での低下が大きかった。これらの指標の縦断的評価については、脱落の効果を小さくする方法をとっての評価がより重要となるであろう。

今後、今回の未受診者データを会場調査データに加えた追跡者全体のデータを用いて、より代表性の高い縦断変化を検討していく予定である。

E．結論

追跡率の向上のため、2011年80歳コホートの2014年の会場招待型による追跡調査の未受診者に対する訪問調査を行った。2011年度ベースライン調査の参加者973名中、会場招待調査で570名が追跡でき、訪問調査により153名が追跡できた。その結果、全体の追跡率は74.3%となった。

未受診者に対する訪問調査の結果、3年後での自立機能および精神的健康の悪化がみられ、脱落効果が示された。初回調査参加者の継時的な変化の全体像をとらえる上で、訪問による未受診者調査を加味した評価が必要であることが確認された。

G．研究発表

なし

H．知的財産権の出願・登録状況（予定を含む。）

なし

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Geriatr Gerontol Int 2015

ORIGINAL ARTICLE: EPIDEMIOLOGY, CLINICAL PRACTICE AND HEALTH

Age and sex differences in the taste sensitivity of young adult, young-old and old-old Japanese

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Aim: The present study examined sex and age differences in taste sensitivity among young adult, young-old and old-old Japanese.

Methods: Participants were divided into three groups comprising 477 men and 519 women in the young-old group (aged 69–71 years), 449 men and 500 women in the old-old group (aged 79–81 years), and 35 men and 35 women in the young adult group (aged 24–32 years). Recognition thresholds for the four basic tastes were measured using the 1-mL whole mouth gustatory test, in which taste solutions of the four basic tastes were tested in five concentrations.

Results: Young adults showed significantly lower recognition thresholds than the young-old group, and the young-old group showed significantly lower recognition thresholds than the old-old group. Among the young-old and old-old groups, women showed significantly lower recognition thresholds than males for sour, salty and bitter tastes, but there was no sex difference in the sweet taste threshold between the two groups.

Conclusions: The present study confirmed that there are age and sex differences in taste sensitivity for the four basic tastes among young adult, young-old, and old-old Japanese, and that the sensitivity of sweet taste is more robust than the other tastes. **Geriatr Gerontol Int 2015; ••: ••–••.**

Keywords: aging, gender difference, taste sensitivity, whole mouth gustatory test.

Introduction

Taste sensitivity is an important factor not only for maintaining life, but also for enjoying food and enhancing the quality of life.[1] The sense of taste is important for identifying healthy nutrients and avoiding unhealthy compounds, such as spoiled or poisonous food. Sweet and salty tastes stimulate our appetite, whereas bitter and sour tastes might be aversive. Chemosensory loss, specifically a decrement in the senses of taste and smell, can lead to inadequate dietary intake, resulting in increased risk of malnutrition as a result of the loss of appetite.[2] Nagai *et al.* reported that there could be a relationship between taste sensation and food consumption.[3]

The influence of aging on taste sensitivity has been investigated in many studies. The decrease in taste sensitivity can vary depending on taste quality. Some investigators found that sweet taste sensitivity decreased with age.[2,4–8] Others found no significant difference in sweet taste sensitivity between the young and the elderly.[9–14] Some investigators have reported a decrease in sour sensitivity with aging,[2,6,9,14–17] whereas others reported no difference between the young and the elderly.[10,18] Similarly, many reports suggest a decline in salt sensitivity[2,6,10,14,17–19] and bitter sensitivity[2,6,12,14,16,17,19] with age.

In 1959, Cohen and Gitman investigated sensitivity to the four basic tastes and suggested that men made more errors in recognition thresholds than women in general.[20] Wardwell *et al.* reported that sweet and bitter

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recognition thresholds were affected by sex in an older group, but not in a younger group, whereas sour and salt recognition thresholds were affected by sex in both young and old.[19] Heft and Robinson reported no sex difference in salty taste sensitivity, but noted a higher sour threshold in men than women.[16] Yamauchi *et al.* showed a significant difference in detection thresholds for bitter tastes between young men and women, but no sex difference in them for sweet, salty or sour tastes, or in recognition thresholds of all four basic tastes.[13]

Thus, the majority of previous studies report a decline in taste sensitivity with age, as well as sex differences. However, most of the sample sizes were small, especially for the old-old population. In developed countries, most people aged in their early 70s are still fit, active and able to care for themselves. However, after the age of 75 years, they will become increasingly frail, a condition marked by serious mental and physical debilitation.[21] Therefore, rather than grouping together all people who have been defined as old, some gerontologists have recognized the diversity of old age by defining subgroups; for example, young-old (65–74 years), old-old (75–84 years) and oldest-old (≥85 years).

It is arguable whether the sensitivity of all four tastes decreases homogeneously or not, and whether there are sex threshold differences for all tastes. Therefore, the purpose of the present study was to examine the sex and age differences in taste sensitivity among young-old, old-old and young adult people in a large-sample cross-sectional study.

Methods

Participants

The present study was approved by the institutional review board of the Osaka University Graduate School of Dentistry (approval number H22-E9). All participants were cognitively eligible and gave written informed consent to participate. Because all participants came to the research venue voluntarily by referring to the map, they were considered cognitively eligible. As a result, persons with dementia were automatically excluded from this study. Additionally, those who could not understand or follow our instructions were excluded for the analysis.

For the elderly groups, data for this study were collected during the baseline assessment for a prospective study of health and longevity called Septuagenarians, Octogenarians, Nonagenarians Investigation with Centenarians (SONIC). Our sample of study participants lived in Itami and Asago cities in Hyogo, Japan, and in Itabashi Ward and Nishitama County, in Tokyo, Japan. Persons aged 69–71 years and 79–81 years were recruited from a complete enumeration of the district. In the present study, the former and the latter were named as "young-old group" and "old-old group", respectively. The sample comprised 477 men and 519 women in the young-old group, and 449 men and 500 women in the old-old group.

The young adults group consisted of 70 students and dental staff (35 men and 35 women, age range 24–32 years), with a mean age of 26.6 ± 3.1 years, who had clinically normal dentition and no taste disorders. All participants were told to avoid intake of food and beverages except for water 1 h before the measuring session.

Stimuli

The 1-mL whole mouth gustatory test was used in the present study.[17] Stimuli representing the four basic tastes (sweet, sour, salty and bitter) were included. Samples were prepared for assessment of sweet (saccharose), salty (sodium chloride), sour (tartaric acid) and bitter (quinine hydrochloride) tastes with double dilutions between successive stimuli concentrations (Table 1). The solution of the highest concentration of each taste was numbered C5 and the lowest was numbered C1 (Table 1). Successive stimuli concentrations were based on previous reports and a preliminary experiment.[8,17] Each compound was diluted with distilled water. Prepared solutions were stored in glass bottles at 4°C until the measuring session, at which time they were brought to normal temperature (approximately 27°C). Because of the light sensitivity of quinine hydrochloride, sample bottles were protected from light.

The recognition threshold, or the lowest concentration at which participants could recognize the taste

Table 1 Concentration of taste solutions

Concentration number	Sweet, saccharose (g/%)	Salty, sodium chloride (g/%)	Sour, Tartaric acid (g/%)	Bitter, quinine hydrochloride (g/%)
C5	4.0	0.5	0.05	0.001
C4	4.0×2^{-1}	0.5×2^{-1}	0.05×2^{-1}	0.001×2^{-1}
C3	4.0×2^{-2}	0.5×2^{-2}	0.05×2^{-2}	0.001×2^{-2}
C2	4.0×2^{-3}	0.5×2^{-3}	0.05×2^{-3}	0.001×2^{-3}
C1	4.0×2^{-4}	0.5×2^{-4}	0.05×2^{-4}	0.001×2^{-4}

quality correctly, was recorded. The gustatory test procedure was carried out as follows. Solutions were drawn into a syringe without a needle and sprayed into the oral cavity. Starting with 1 mL of the lowest concentration (C1), participants were instructed to hold the liquid in their mouth for 10 s at the most and then describe the sample as one of the four taste qualities, an unidentified taste or no taste. If the participant answered correctly, the concentration was taken as the recognition threshold. If the participant could not identify the taste correctly, even in the highest concentration, it was evaluated as "burst." Three taste qualities (sweet, sour and salty) were randomized so that the participants could not anticipate the next taste quality. Because the bitter taste remains longer than the other tastes, it was tested last. Dentures, if present, were not removed during the examination. The time required for completion of the test was less than 5 min for each person. For the young adult group, we examined gustatory response using C1 to C5. However, for the older (young-old and old-old) groups, there were few participants who recognized taste quality with C1, except for bitter taste. To avoid a waste of time and fatigue of old participants, we examined using from C2 to C4.

Statistical analysis

Statistical analysis was carried out using SPSS version 20.0 for Windows (SPSS, Chicago, IL, USA). The Kruskal–Wallis test, Bonferroni correction for multiple comparisons, and the Mann–Whitney *U*-test were applied to investigate the effects of age and sex for the four basic tastes. *P*-values ≤0.05 were considered significant.

The total sample size was estimated as approximately 304 for each group by G* power when the defined effect size was 0.3, α error was 0.05, power = 1-β error was 0.95; therefore, the number of study participants was sufficient for our study.

Results

Table 2 shows systemic diseases, medications, and dental status of the young-old and old-old groups. There were significant differences in all these factors between the both groups. All young adult participants were classified in Eichner's A group, and did not use a removable denture, and did not have any medication and systemic disease.

All young adult participants detected the four basic tastes correctly with the highest concentration (C5). However, the rate of "burst" when older participants could not identify the taste correctly was 1.3% for sweet, 6.3% for sour, 6.7% for salty and 29.2% for bitter in the young-old group, and 3.5% for sweet, 18.8% for sour, 13.2% for salty and 37.9% for bitter in the old-old group.

Figure 1 shows the cumulative threshold curves for each taste in each age group. Overall, young adults showed significantly lower recognition thresholds than the young-old group, and the young-old group showed significantly lower recognition thresholds than the old-old group ($P < 0.01$ after Bonferroni correction), except for sweet taste sensitivity between young adults and the young-old group (Supporting Tables S1 and 2).

Figure 2 shows that among the young-old and old-old groups, women showed significantly lower recognition thresholds than men for sour, salty and

Table 2 Oral and systemic status of young-old and old-old groups

Variables		Young-old (n = 996)	Old-old (n = 949)	*P*
No. teeth	Median (25–75th quartile)	23 (16–27)	18 (6–24)	<0.001
Eichner's classification	A (%)	50.1	13.6	<0.001
	B (%)	23.7	50.7	
	C (%)	17.3	35.7	
Denture use				
Upper	(%)	33.8	56.4	<0.001
Lower	(%)	29.2	55.5	<0.001
Medication intake	(%)	75.8	91.1	<0.001
Systemic diseases	(%)	73.5	86.6	0.035
Smoking				
Male	(%)	67.8	72.5	0.077
Female	(%)	8.4	5.2	0.033
Drinking				
Male	(%)	52.6	42.3	0.002
Female	(%)	9.2	4.5	0.003
Xerostomia	(%)	37.0	41.0	0.041

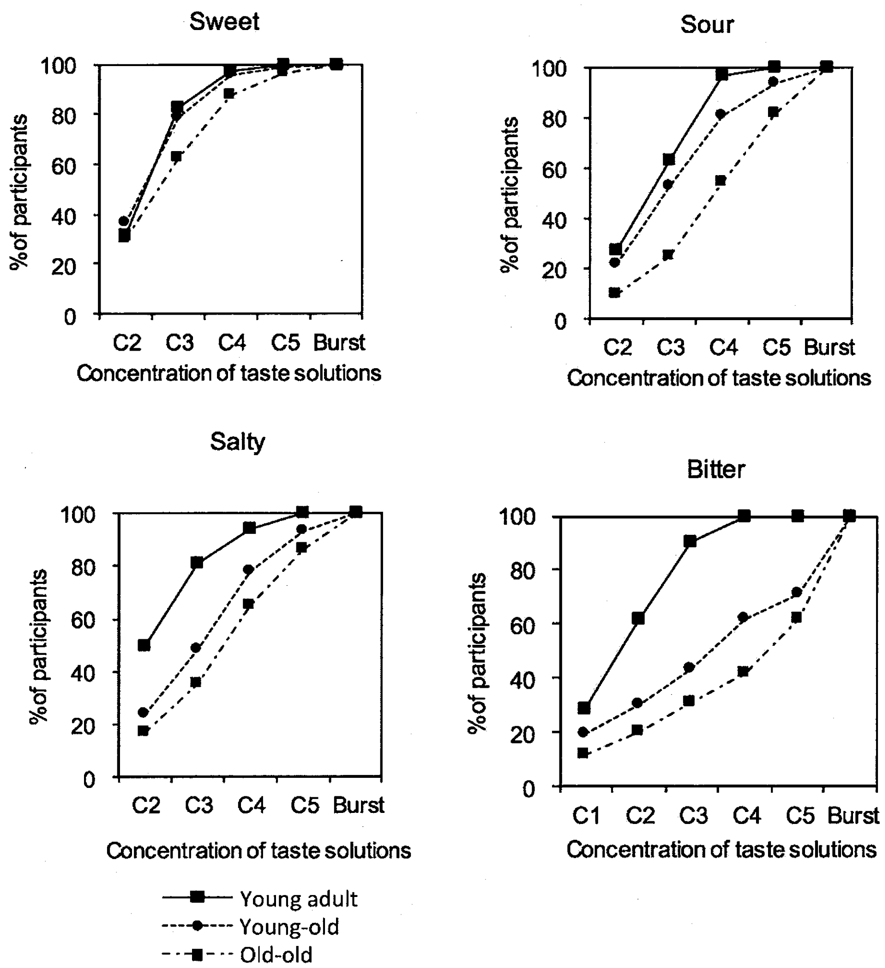

Figure 1 Cumulative taste threshold curves in different age groups.

bitter tastes ($P < 0.01$; Supporting Tables S3 and 4). However, there was no sex difference in the sweet taste threshold in both the age groups. There was no significant difference in the sensitivity of all taste qualities between the young men and women.

As shown in Table 3, smoking habit showed a significant relationship to sour, salty and bitter taste sensitivity in the young-old group, and was related to sour and bitter taste sensitivity in the old-old group. Furthermore, drinking habit had relationship to sweet, sour and bitter taste sensitivity in the young-old group, and was related to sour, salty and bitter taste sensitivity in the old-old group. However, denture use, xerostomia at the time of awakening and medication had no relationship to all the taste sensitivity.

Discussion

The present study investigated age and sex differences in taste sensitivity for the four basic tastes among young adult, young-old and old-old Japanese. It also confirmed the robustness of sweet taste sensitivity when compared with other taste qualities.

The 1-mL whole mouth method[13,17] is easier to carry out than taste strip tests[22] or electrogustometry,[23] and requires less than 10 min per participant. Murphy *et al.* also found a poor correlation between electrical gustatory thresholds and taste thresholds for sour and salty tastes.[23] The filter paper disc method is useful for separately examining three gustatory nerves, the chorda tympani, the glossopharyngeal and the greater petrosal; however, it requires approximately 30 min per subject.[24,25] Because the elderly group consisted of a large number of participants, the whole-mouth method was appropriate in the present study.

In our study, there was no difference between the young-old and young adult groups for sweetness acuity. This result is in accordance with several reports.[9,11,12,14,18] Receptor cells for the four basic tastes are known to be different, so their decline might be non-homogeneous. The receptors for salt and sour perceive taste through ion channels, whereas sweet and bitter taste receptors respond to proteinaceous components.[26] Murphy and Gilmore suggested that the differential effects of aging on different taste quality sensitivity could be due to the distinct cellular mechanisms of taste transduction.[27] McBride and Mistretta suggested that responses to the

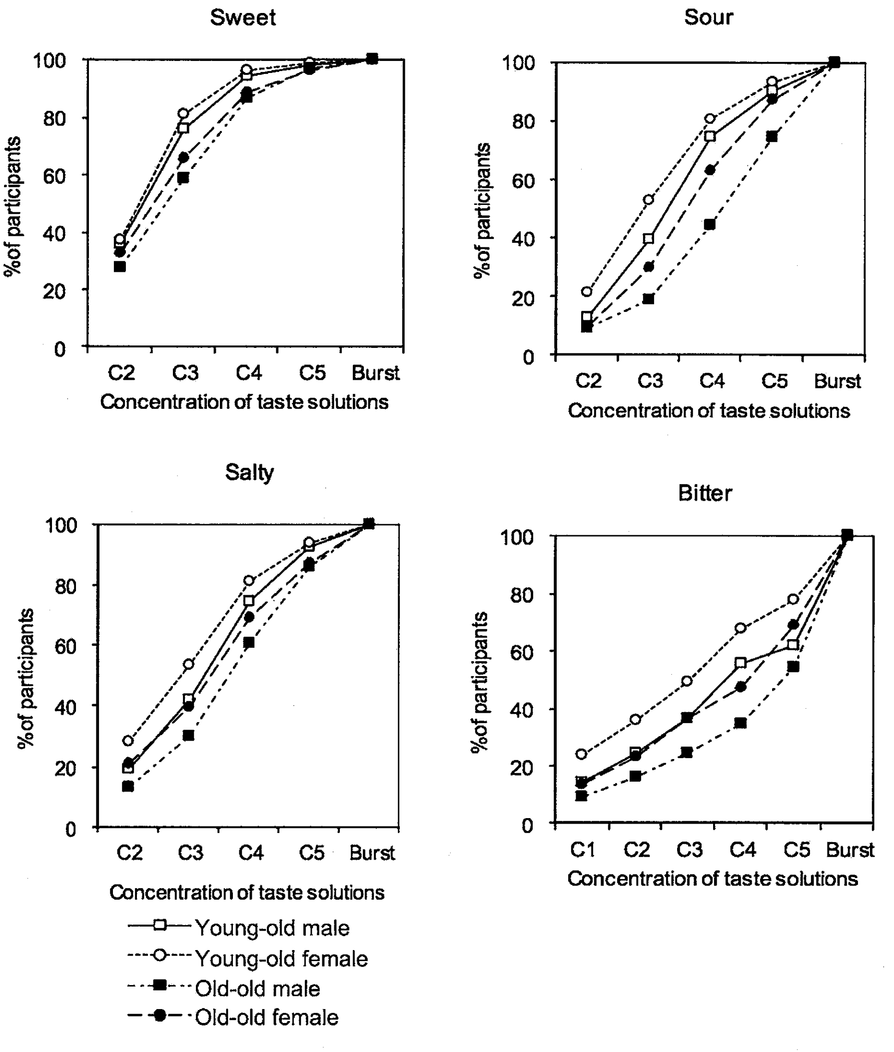

Figure 2 Cumulative taste threshold curves by sex among septuagenarians and octogenarians.

sweet stimulus (sucrose) are relatively well preserved with age in comparison with responses to the salt stimulus (sodium chloride) in rats.[28] Thus, the taste receptor for sweet might be more resistant to the effects of aging. However, we found that the sweet threshold was higher in the old-old group than the young-old group, which suggests that sweetness acuity also declines in a similar manner to the other taste qualities during the late 70s.

Unlike sweetness acuity, sensitivities to the other three tastes had already decreased among the young-old group in the present study. Among the taste qualities, the difference between the young adult and the young-old groups was greatest for bitterness acuity. Liking sweet and disliking bitter are characteristics of humans that are present from infanthood. The tastes of bitterness and sourness are generally rejected by infants and children. Naturally-occurring anti-oxidants and anti-inflammatory compounds are generally bitter, yet people are encouraged to ingest them. Through experience, individuals learn to appreciate some bitter foods that facilitate health. Habitual ingestion of bitter foods leads to a consequent decline in bitterness acuity. In addition, drinking and smoking habits are likely to reduce acuity of sourness and bitterness. Although the mechanism is unclear, the taste-decreasing effect by smoking and drinking is serious in young-old and old-old groups. This could be linked to the great difference in the thresholds for sour and bitter tastes between young and older people.

Weiffenbach *et al.* reported that human senses, except for pressure, decline with age.[10] Taste in particular is a very complex modality related to the influence of numerous internal and external factors. Naturally, there are great differences in mental and physical debilitation between older individuals. Many patients with various diseases develop taste disorders, including taste loss and taste distortion.[29] Furthermore, decreased taste sensitivity or total loss of taste sensitivity is described as an adverse effect of various medications.[26] Indeed, most of the older participants in our study took medicine – 75.8% of the young-old group and 91.1% of the old-old group, respectively. The rate of "burst" was 2.7% for

Table 3 Relationship between taste sensitivity and oral and systemic status in young-old and old-old groups

		Sweet Median (25–75%)	*P*	Sour Median (25–75%)	*P*	Salty Median (25–75%)	*P*	Bitter Median (25–75%)	*p*
Young-old group	Smoking								
	No	3 (2–4)		3 (2–4)		3 (2–4)		5 (3–B)	
	Yes	3 (2–4)	0.668	4 (3–4)	0.001	4 (3–4)	0.003	5 (3–B)	0.021
	Drinking								
	No	3 (2–3)		3 (3–4)		4 (2–4)		5 (3–B)	
	Yes	3 (2–3)	0.045	4 (3–5)	0.001	4 (3–5)	0.147	5 (3–B)	0.023
	Upper denture usage								
	No	3 (2–3)		3 (3–4)		3 (3–4)		5 (3–B)	
	Yes	3 (2–3)	0.174	3 (3–4)	0.554	4 (3–5)	0.050	5 (3–B)	0.314
	Lower denture usage								
	No	3 (2–3)		3 (3–4)		4 (3–4)		5 (3–B)	
	Yes	3 (2–3)	0.902	3 (3–4)	0.886	4 (3–4)	0.323	5 (3–B)	0.552
	Xerostomia								
	No	3 (2–3)		3 (3–4)		4 (3–4)		5 (3–B)	
	Yes	3 (2–3)	0.606	3 (3–4)	0.913	3 (2–5)	0.664	5 (3–B)	0.994
		Sweet		Sour		Salty		Bitter	
	No. medications	rs	*P*	rs	*P*	rs	*P*	rs	*P*
		0.044	0.181	−0.032	0.315	−0.054	0.091	0.054	0.099
		Sweet Median (25–75%)	*P*	Sour Median (25–75%)	*P*	Salty Median (25–75%)	*P*	Bitter Median (25–75%)	*P*
Old-old group	Smoking								
	No	3 (2–4)		4 (3–5)		4 (3–5)		B (4–B)	
	Yes	3 (2–4)	0.080	5 (4–5)	0.001	4 (3–5)	0.090	B (4–B)	0.011
	Drinking								
	No	3 (2–4)		4 (3–5)		4 (3–5)		B (4–B)	
	Yes	3 (2–4)	0.131	5 (4–B)	0.001	4 (3–5)	0.049	B (4–B)	0.005
	Upper denture usage								
	No	3 (2–4)		4 (4–5)		4 (3–5)		B (4–B)	
	Yes	3 (2–4)	0.445	4 (4–5)	0.233	4 (3–5)	0.816	B (4–B)	0.872
	Lower denture usage								
	No	3 (2–4)		4 (4–5)		4 (3–5)		B (4–B)	
	Yes	3 (2–4)	0.054	4 (4–5)	0.945	4 (3–5)	0.165	B (4–B)	0.703
	Xerostomia								
	No	3 (2–4)		4 (4–5)		4 (3–5)		B (4–B)	
	Yes	3 (2–4)	0.126	4 (3–5)	0.876	4 (3–5)	0.257	B (4–B)	0.351
		Sweet		Sour		Salty		Bitter	
	No. medications	rs	*P*	rs	*P*	rs	*P*	rs	*P*
		0.086	0.008	−0.082	0.012	−0.057	0.081	−0.037	0.250

sweet, 6.4% for sour, 5.1% for salty and 37.3% for bitter in the young-old group taking no medicine, and 3.6% for sweet, 28.6% for sour, 17.9% for salty and 71.4% for bitter in the old-old group taking no medicine. Deterioration of the dentition in older people could also influence sensory perception. Wayler *et al.* found that covering the palate with a prosthesis affected taste acuity.[11] In the present study, however, there was no significant difference in any taste sensitivity between upper complete denture wearers and the participants without denture use. Thus, in addition to physiological aging, the old-old group has more risk of developing taste disorders as a result of systemic diseases, medications and dental status than the young-old group. In these participants, 37% of young-old group and 41% of the old-old group complained of xerostomia on awakening. Although, xerostomia might be considered a risk factor of taste decline, it had no significant association with sensitivity of any taste in the present study by Mann–Whitney *U*-test. Associations between the possible factors should be determined in the next investigation.

The results of our study are mostly in accordance with the previous studies in relation to sex differences, that taste sensitivity is more prone to deteriorate in men than in women, both among the young-old group and the old-old group, except for the sweet taste threshold. The reasons for the sex difference might be due not only to genetic factors, but also to factors such as lifestyle-related diseases, medications for the diseases, and smoking and drinking habits. In the older Japanese generation, men are more likely to smoke, drink and suffer from cardiovascular diseases than women.[30] Although there was no significant sex difference in medication intakes, smoking and drinking habits had significant sex differences by a χ^2-test both in the young-old and old-old groups. These factors might have some effects on the results, as more than two-thirds of the men, while less than 10% of the women, had current and past smoking habits. Similarly, almost a half of the men, while less than 10% of the women, had a drinking habit. It is also possible that among the older population, the biological age of women is lower than men at the same chronological age when the difference in their life expectancy is taken into account.

A possible scenario is as follows: there is no significant sex difference in taste acuity at the stage of youth. Decline in taste sensitivity occurs during aging, so the thresholds for sour, salty and bitter taste increase even in the young-old stage, especially in men. This means the deterioration in the ability to avoid poisons and rotten food, and the possibility of excessive salt intake. Sweetness acuity is comparatively stable, finally declining in the late 70s. The sense of sweet taste, in particular, remains robust into old age. Because old people are seldom aware of taste disorders, appetite and nutrition intake might be affected without their knowledge. This is an important point to be remembered when designing and preparing food for older people.

One strength of the present study was that the sample size of old-old participants was larger than those of previous studies. However, several limitations should be mentioned. The present study population came from a narrow range, and included only non-institutionalized, community-dwelling and age-homogeneous Japanese people in limited areas, most of whom were physically and cognitively healthy despite the sample being drawn from a complete enumeration of residents. Additionally, the young group was small in number and was limited to dental staff and students.

Age and sex differences in taste sensitivity in elderly people clearly exist, although various factors influence taste sensitivity ability. Further studies are required to interpret individual variations in taste sensitivity. Definitive elucidation of changes in taste sensitivity in later life would require a prospective cohort study.

Within the limitations outlined, the present study clarified age and sex differences in taste sensitivity for the four basic tastes among young adult, young-old and old-old Japanese. It also confirmed the robustness of sweet sensitivity above the other tastes. It was clinically implied that taste alteration, leading to reduced appetite, should be one of the factors to be considered for prevention of inadequate dietary intake in older people.

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Disclosure statement

No potential conflicts of interest were disclosed.

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Supporting information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

Table S1 Median and 25–75% quartile range of each age group for four primary tastes.
Table S2 Comparison of each age group for four primary tastes.
Table S3 Median and 25–75% quartile range of each age and sex group for four primary tastes.
Table S4 Comparison of each sex group for four primary tastes.

Lower Protein Intake Mediates Association Between Lower Occlusal Force and Slower Walking Speed: From the Septuagenarians, Octogenarians, Nonagenarians Investigation with Centenarians Study

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OBJECTIVES: To investigate the association between lower extremity motor function and occlusion in older adults and to examine the possibility of dietary intake of protein mediating the association.

DESIGN: Cross-sectional, population-based study.

SETTING: Urban and rural area in Japan.

PARTICIPANTS: Community-dwelling septuagenarians (N = 655) and octogenarians (N = 629).

MEASUREMENTS: Information was collected on occlusal force, protein intake, grip strength, walking speed, sociodemographic characteristics, and medical history. Multivariable logistic regression analysis was used to investigate the association between walking speed, occlusal force, and protein intake, and structural equation modeling analysis and mediation analysis were performed to investigate the validity of the hypothesized model and identify the indirect effect of protein intake in occlusal force and walking speed.

RESULTS: The proportion of participants whose walking speed was 0.8 m/s or slower (slow walking speed) was 27.7%. Logistic regression analyses showed that slower walking speed was associated with occlusal force (odds ratio = 1.57, $P = .001$) after adjusting for medical history, body mass index, grip strength, and protein intake. The fit of the hypothesized model that walking speed was associated with occlusal force through protein intake was good, and the indirect effect was significant.

CONCLUSION: Slower walking speed was associated with lower occlusal force. Lower protein intake mediated the association between walking speed and occlusal force. Maintaining occlusal force might prevent insufficient nutrition intake and further deterioration of motor function in older people. **J Am Geriatr Soc 63:2382–2387, 2015.**

Key words: occlusal force; protein intake; walking speed; elderly people

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An association between occlusion and motor function has recently been reported. Motor function of the lower extremities has been found to be associated with the Eichner index, which is based on existing natural tooth contacts between the maxilla and mandible in the bilateral premolar and molar regions,[1,2] and the Timed Up and Go Test (one of the indices of lower extremity performance) was found to be positively associated with occlusal force[3] and the Eichner index.[4] The proposed mechanism for the association was that nutrition intake may mediate between occlusion and motor function, although this has not been demonstrated.

The association between occlusion and nutrition intake is well known, with reports that loss of teeth is responsible for older people consuming predominantly soft

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and easy-to-chew foods,[5–7] leading to poor dietary practices and marginal nutrition intake.[8] Moreover, older people with fewer opposing tooth pairs tend to avoid stringy foods such as meat,[9] and an association between number of teeth and protein intake has been reported, with intake of many nutrients (including protein) lower in people with fewer teeth.[10] Thus, it is likely that occlusion influences intake of essential nutrients such as protein.

Where nutrition intake and motor function are concerned, inadequate protein intake appears to influence muscle tissue mainly by reducing its synthesis rather than by increasing the degradation of muscle protein.[11,12] Sufficient protein intake plays an important role in preventing loss of skeletal muscle in older people.[13]

Accordingly, it was hypothesized that compromised masticatory ability (represented by lower occlusal force) would lead to insufficient protein intake, which (in turn) would result in deterioration in skeletal muscle mass and function, represented by lower extremity walking speed. Previous research has not investigated these together. Therefore, the purpose of this study was to investigate these associations in older Japanese people.

METHODS

Study Sample

This cross-sectional study was conducted as a baseline assessment in the Septuagenarians, Octogenarians, Nonagenarians Investigation with Centenarians (SONIC) study, a prospective study investigating health and longevity. The research data were collected from two main regions of eastern and western Japan (Tokyo metropolitan area, Hyogo prefecture, respectively). In addition, an urban area and a rural area are included in each region (Itami City, Hyogo (western urban); Asago City, Hyogo (western rural); Itabashi ward, Tokyo (eastern urban); Nishitama County, Tokyo (eastern rural)). All study participants were cognitively capable enough to reach the research venue by referring to a map. Persons with dementia and those who could not walk (e.g., in a wheelchair) or understand or follow instructions were excluded from the analysis. Data collection was conducted during 1 day in 2010 and 2011 at each community center.

The institutional review board of Osaka University Graduate School of Dentistry approved the study protocol (approval H22-E9). All participants provided written informed consent to participate.

Occlusal Force

Bilateral maximal occlusal force was measured using 97-μm-thick pressure-sensitive sheets (Dental Prescale, Type-R; Fuji Film Co., Tokyo, Japan). Participants were instructed to bite the sheets in the intercuspal position as strongly as they could. Those who had removable dentures wore them during measurement. The pressure-sensitive sheet consists of a film enclosing colorless dye that breaks down as a result of occlusal pressure and becomes colored in proportion to the pressure exerted. Occlusal force is then determined from color development in the pressure-sensitive sheet using special analytical equipment (Occluzer FDP703; Fuji Film Co.). The uses, limitations, validity, and reliability of this method have been discussed and reported previously.[14,15]

Protein Intake

Recall information on dietary habits during the preceding month was collected using a validated, self-administered brief diet history questionnaire (BDHQ), a structured four-page, fixed-portion questionnaire that asks about consumption frequency of selected foods, but not about portion size, to estimate the dietary intake of 58 food and beverage items. The BDHQ was sent ahead of time, and participants were instructed to answer all questions by the data collection day. This was then checked on the day of the assessment. Participants did not record their daily diet. The methods used to calculate dietary intake and the validity of the BDHQ have been detailed elsewhere.[16,17] Intake of energy and selected nutrients was estimated using an ad hoc computer algorithm for the BDHQ, which was based on the Standard Tables of Food Composition in Japan and developed and validated in earlier research.[16,17] Protein intake was energy-adjusted using the density method (percentage of energy) to minimize the influence of dietary misreporting.

Walking Speed

To measure skeletal muscle function, the time taken to walk 8 feet at normal speed was measured twice, and the two measurements were averaged to give the usual walking speed. In this study, participants were defined as having low walking speed if their usual walking speed was 0.8 m/s or slower.

Grip Strength

Isometric grip strength was measured using a Smedley handgrip dynamometer (Model YD-100; Yagami Ltd, Tokyo, Japan), which consists of a gripping handle with a strain gauge and an analog reading scale (kg). The test was performed two times on the dominant hand with the participant in a sitting position with the arm held against the body, and the average was calculated. Participants were instructed to hold the metal handles of the dynamometer and, after adjusting the handle under the second phalanx of the fingers when gripped (or to the second metatarsal), to keep their arm at a 90° angle and squeeze as hard as they could.

Sociodemographic Characteristics

Assessments of sociodemographic characteristics were based on responses to a separate questionnaire. Participants were divided into the groups based on years of education (<10, 10–12, >12) and subjective financial status (dissatisfied, moderately satisfied, satisfied).

Anthropometry and Self-Reported Medical History

Height and weight were measured, and body mass index (BMI) was calculated as weight (kg) divided by the square of height (m^2). Relevant medical history was determined by asking whether they had had cardiovascular disease, a stroke, or a malignant tumor.

Statistical Analysis

After computation of summary statistics, differences between means were tested for statistical significance using analysis of variance (or appropriate nonparametric tests when continuous data were not normally distributed); chi-square tests were used for differences between proportions. Multivariable logistic regression analysis was used to examine the association between occlusal force or protein intake and walking speed. The dichotomized dependent variable was walking speed of 0.8 m/s or slower (1) or faster than 0.8 m/s (0). Protein intake was divided into four groups according to percentile (<25th (reference), 25–50th, 50–75th, > 75th). Occlusal force and grip strength were divided into two groups according to percentile (<25, ≥25th (reference). Percentile cutoffs for protein intake, occlusal force, and grip strength were defined separately according to sex and age. Sociodemographic characteristics, medical history, region, and BMI were controlled for in the model. These statistical analyses were conducted using SPSS version 20.0 (IBM Japan, Tokyo, Japan). Significance was set at .05.

Structural equation modeling (SEM) analysis (AMOS 20, IBM) was used to examine the indirect effect of protein intake on occlusal force and walking speed and to examine the hypothesized model fit. Chi-square statistics, root mean square error of approximation (RMSEA), and the goodness-of-fit index (GFI) were used as fit indices. Greater chi-square values and lower *P*-values indicate poorer fit of the model. $P < .05$ for the chi-square in the model indicates poor fit. The RMSEA is a popular index based on the error of approximation. Generally, a RMSEA[18] less than 0.05 indicates close fit, between 0.05 and 0.08 indicates reasonable fit, and more than 0.1 indicates poor fit. The GFI[19] is an absolute fit index that estimates the proportion of variability in the sample covariance matrix that the model explains. A GFI of 1.0 indicates a perfect model fit, and greater than 0.95 may indicate good fit. Mediation analysis with bootstrapping methods was performed to examine the indirect effect of occlusal force on walking speed through protein intake. The 95% bias-corrected accelerated confidence intervals were calculated based on 1,000 bootstrap samples.

RESULTS

All community-dwelling individuals aged 69 to 71 (septuagenarians; 2,071 male, 2,196 female) and 79 to 81 (octogenarians; 2,241 male, 3,137 female) in each area were identified from the local residential registration and contacted by mail. The total number of possible participants was 9,645. Of those, 1,000 septuagenarians (477 male,

Table 1. Participant Characteristics According to Walking Speed

Characteristic	n (%)	≤0.8 m/s, n = 356	>0.8 m/s, n = 928	*P*-Value
Sex, %				
Male	623 (48.5)	29.4	70.6	.20[a]
Female	661 (51.5)	26.2	73.8	
Age, %				
70–79	655 (51.0)	22.7	77.3	<.001[a]
80–89	629 (49.0)	32.9	67.1	
Economic status, %				
Dissatisfied	266 (20.7)	30.1	69.9	.03[a]
Moderately satisfied	711 (55.4)	29.4	70.6	
Satisfied	307 (23.9)	21.8	78.2	
Education, years, %				
<10	318 (24.8)	34.0	66.0	.003[a]
10–12	570 (44.4)	27.9	72.1	
>12	396 (30.8)	22.5	77.5	
Cardiovascular disease, %				
No	1,126 (87.7)	27.3	72.7	.32[a]
Yes	158 (12.3)	31.0	69.0	
Stroke, %				
No	1,249 (97.3)	27.1	72.9	.005[a]
Yes	35 (2.7)	48.6	51.4	
Malignant tumor, %				
No	1,142 (88.9)	27.6	72.4	.75[a]
Yes	142 (11.1)	28.9	71.1	
Body mass index, kg/m^2, median (IQR)		22.9 (21.1–24.9)	22.2 (20.4–24.1)	<.001[b]
Grip strength, kgf, median (IQR)		21.0 (15.6–29.7)	23.0 (18.3–30.3)	.001[b]
Occlusal force, N, median (IQR)		303.8 (142.6–534.6)	398.8 (214.6–662.1)	<.001[b]
Protein intake (percentage of energy, g/kcal), median (IQR)		15.6 (13.5–17.9)	16.2 (14.2–18.4)	.002[b]

[a] Chi-square test.
[b] Mann–Whitney *U* test.
IQR = interquartile range.

523 female) and 973 octogenarians (457 male, 516 female) took part in the SONIC Study (20.4% of the original number). Individuals with extremely low or high reported energy intake (<600 or ≥4,000 kcal/d), currently receiving dietary counseling from a doctor or dietitian, or with intentional dietary change during the preceding year were excluded (n = 382, 4.0%). A further 307 participants (3.2%) who could not complete each research item were excluded when the analyses were conducted, leaving 1,284 participants (13.3%) for analysis (n = 655 septuagenarians (313 male, 342 female); 629 octogenarians (310 male, 319 female)).

The average number of teeth was 20.7 ± 8.4 for septuagenarians and 15.3 ± 10.1 for octogenarians. Median walking speed (m/s) was 0.92 (interquartile range 0.78–1.08); 356 participants (27.7%) had slow walking speed (≤0.8 m/s). Table 1 presents participant characteristics according to walking speed. Septuagenarians and participants who were satisfied economically; had not had a stroke; and had more education, faster walking speed, higher BMI, greater grip strength, greater occlusal force, and greater protein intake had faster walking speed.

In the logistic regression analysis for slower walking speed (Table 2), less-educated people and those who had had a stroke (odds ratio (OR) = 2.67) or had a higher BMI (OR = 1.08) or weaker grip strength (OR = 1.51) or occlusal force (OR = 1.57) had greater odds of slower walking speed. There was a gradient according to protein intake, whereby those with higher protein intake had lower odds of having slower walking speed (25–50th, OR = 0.75; 50–75th, OR = 0.66; >75th, OR=0.63). The Nagelkerke coefficient of determination (0.09) and the Hosmer-Lemeshow test (*P* = .39) suggested a good fit.

Table 2. Logistic Regression Model for Slower Walking Speed

Independent Variable	Odds Ratio (95% Confidence Interval)	*P*-Value
Economic status (reference dissatisfied)		
Moderately satisfied	1.02 (0.74–1.40)	.91
Satisfied	0.78 (0.52–1.15)	.20
Education, years (reference <10)		
10–12	0.85 (0.62–1.15)	.29
>12	0.65 (0.46–0.92)	.01
Cardiovascular disease	1.12 (0.77–1.62)	.56
Stroke	2.67 (1.33–5.37)	.006
Malignant tumor	1.11 (0.74–1.65)	.61
Body mass index, kg/m^2 (continuous)	1.08 (1.04–1.13)	<.001
Grip strength <25th percentile, kgf[a]	1.51 (1.14–1.99)	.004
Occlusal force <25th percentile, N[a]	1.57 (1.19–2.07)	.001
Protein intake percentile, g/kcal, (reference <25th)[a]		
25–50th	0.75 (0.53–1.06)	.10
50–75th	0.66 (0.46–0.93)	.02
>75th	0.63 (0.44–0.90)	.01

Walking speed: >0.8 m/s = 0, ≤0.8 m/s = 1.
Nagelkerke coefficient of determination = 0.09.
Hosmer-Lemeshow test *P* = .39.
[a] Cutoff values were defined separately according to age and sex.

The SEM analysis (Figure 1) confirmed the hypothesis that walking speed is associated with occlusal force directly and also indirectly, through protein intake. In the SEM outcome, walking speed was associated with occlusal force (standardized direct effect = 0.11, *P* < .001) and protein intake (standardized direct effect = 0.09, *P* < .001), and protein intake was associated with occlusal force (standardized direct effect = 0.10, *P* = .001). The hypothesized model also showed an acceptable good fit, and mediation analysis showed that the indirect effect of occlusal force on walking speed through protein intake was significant (*P* = .001).

DISCUSSION

This study was designed to determine the association between occlusal force and walking speed mediated by protein intake using conventional and SEM analysis in community-dwelling septuagenarians and octogenarians. Slower walking speed was associated with lower occlusal force and insufficient protein intake, and insufficient protein intake was found to be one of the mechanisms through which slower walking speed was associated with lower occlusal force in older people.

Before considering the findings, it is appropriate to consider the weaknesses and strengths of this study. One weakness was that the participation rate (20.4%) was slightly lower than that seen in similar studies (21.0%,[20] 25.0%[21]), although grip strength and walking speed were similar to observations from a previous study on older community-dwelling Japanese adults.[22] In addition, the average number of teeth in septuagenarians (20.7) and octogenarians (15.3) was similar to the estimates of number of teeth for the same age groups (19.5 and 13.0, respectively) from the 2011 Survey of Dental Diseases by the Japanese Ministry of Health, Labour, and Welfare. Another limitation is that this study used a cross-sectional

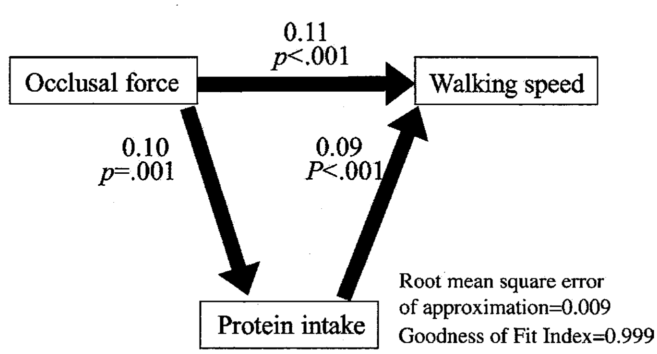

Figure 1. Outcome of structural equation modeling analysis. The values in this figure show standardized direct effects, *P*-values, and fit indices. Goodness of fit of the model was evaluated using the chi-square test. Larger *P* -values indicate better fit, and *P* = .359 implies good fit. Occlusal force and walking speed were adjusted for grip strength; occlusal force, walking speed, and grip strength were adjusted for sex, age, economic status, and educational status; walking speed was adjusted for body mass index and medical history; and protein intake was adjusted for sex, age, economic status, and educational status. The mediation effect of occlusal force on walking speed through protein intake was significant (*P* = .001).

design, which cannot establish a cause-and-effect relationship. Although the data were modeled based on the causal ordering hypothesized from previous evidence, no causality can be assumed, because all variables were measured at the same time. Definitive elucidation of the complex relationship between occlusal force and walking speed would require a prospective cohort study. Among the study's strengths were that the sample came from a range of areas and that specialists in dentistry, medicine, nutrition, and human science designed the data collection for their own research areas, which enabled coverage of a number of important confounding factors (e.g., medical history, sociodemographic characteristics, BMI).

The study findings suggest that insufficient protein intake is one of the mechanisms through which slower walking speed is associated with lower occlusal force. The independent associations between occlusal force and walking speed and between protein intake and walking speed in the logistic regression analysis were confirmed in the SEM analysis, in which occlusal force was associated (not only indirectly, but also directly) with walking speed. Other mechanisms should also be considered. For example, insufficient energy or vitamin D intake may lead to deterioration in motor function.[23–26] Moreover, decline in occlusal force might indicate other genetic or environmental risk factors that also affect motor function.

The standardized direct effects in the SEM analysis were low. Others have reported weak associations in such analyses.[1] A 3-year cohort study found that protein intake at baseline predicted muscle mass at follow-up,[27] which supports the current study finding. The observed association between occlusion and protein intake is consistent with previous findings that insufficient protein intake was associated with fewer teeth.[10] Thus, the weak but detectable associations between occlusal force, protein intake, and walking speed in the current study have biological plausibility. Replication of these findings in other populations would further clarify the relationships.

The authors believe that this is the first study to explore how motor function is associated with occlusion. Several studies have found an association between oral health and motor function, but no study has indicated the possible mechanism for the association. The current study findings indicate that slower walking speed is associated with lower occlusal force and that lower protein intake mediates this association between walking speed and occlusal force. Although older people tend to have fewer teeth and lower occlusal force, the dual strategy of preventing ongoing tooth loss and providing adequate prosthodontic treatment should maintain occlusal force, helping them to maintain sufficient protein intake, which should help to ensure the maintenance of motor function.

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Author Contributions: Ikebe, Okada, Gondo, Takahashi, Maeda: project concept and design, development of overall research plan. Okada, Ikebe, Kagawa, Inomata, Takeshita: data collection for dental status, evaluation of oral function. Inomata, Okubo: data collection for dietary intake, evaluation of nutritional status. Gondo, Ishioka: data collection for motor function. Kamide, Arai, Takahashi: data collection for medical status. Okada, Ikebe, Thomson: statistical analysis. Ikebe, Thomson: writing and had responsibility for final content of manuscript. All authors read and approved the final manuscript.

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Impact on Dietary Intake of Removable Partial Dentures Replacing a Small Number of Teeth

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The aim of this study was to clarify the impact of wearing removable partial dentures (RPDs) replacing a small number of teeth on dietary intake. Participants had at least 20 teeth and were classified as Eichner B1 or B2. The participants underwent dental and oral examinations, and their dietary intake was assessed. Analysis of covariance showed that RPD wearers consumed more vegetables, n-3 fatty acids, calcium, vitamin A, and dietary fiber than nonwearers after adjusting for possible confounding factors. It is concluded that RPDs are effective for improving dietary intake even in participants who have lost a small number of teeth. *Int J Prosthodont 2015;28:583–585. doi: 10.11607/ijp.4306*

In Japan, patients usually request removable partial dentures (RPDs) for missing molars. Many reports have suggested that treatment with RPDs is not significantly effective in recovering oral function for shortened dental arches (SDAs),[1] and patients with SDAs require more time to chew test food particles to a suitable size before swallowing than patients with complete dental arches.[2] This study aimed to clarify the impact on dietary intake of wearing RPDs in patients who have lost a small number of teeth.

Materials and Methods

The SONIC Study[3] included 1,970 participants aged 69 to 71 and 79 to 81 years. Participants were chosen who had at least 20 teeth and were classified as Eichner B1 or B2. The final analysis sample comprised 244 participants divided into two groups according to whether or not they wore RPDs (Table 1).

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Age, sex, and socioeconomic status (SES: self-rated financial status, education level, and living area) were established via interview (Table 1). To evaluate oral function, bilateral maximal occlusal force (OF)[3] and stimulated salivary flow rate (SSFR) were measured while the participant chewed paraffin wax, and occlusal units (OUs), defined as pairs of occluding teeth in the posterior region, were assessed. A pair of premolar teeth was labelled as 1OU, a pair of molar teeth was labeled as 2OU, and the sum of OU was defined as OUs ($0 \le OUs \le 12$). Periodontitis was evaluated by measuring the mean of the pocket probing depth (PPD). Diet during the preceding month was assessed with a brief-type self-administered diet history questionnaire (BDHQ).[4] Values of nutrients and food intake were energy-adjusted using the density method.

Age, sex, SES, BMI, oral function, PPD, number of teeth, and energy intake were compared between RPD wearers and nonwearers. Next, analysis of covariance (ANCOVA) was conducted to compare food and nutrition intake adjusted for age, sex, SES, oral function, and PPD. $P < .05$ was considered significant.

The study protocol was approved by the Institutional Review Board (IRB) of Osaka University Graduate School of Dentistry (approval number H22-E9).

Results

The proportion of RPD wearers was significantly higher in 80-year-old participants than in 70-year-old participants (Table 1). PPD was significantly larger in RPD wearers than in nonwearers. No significant differences were found in sex, SES, BMI, oral function, number of teeth, or energy intake between the two groups.

Table 1 Characteristics of Participants

	RPD nonwearers (n = 106)		RPD wearers (n = 138)		
	n	%	n	%	*P* value
Age					.007*
70	64	60.4	58	42.0	
80	42	39.6	80	58.0	
Sex					.067*
Male	58	54.7	61	44.2	
Female	48	45.3	77	55.8	
Self-rated financial status					.648*
Dissatisfied	21	19.8	23	16.7	
Moderately satisfied	56	52.8	81	58.7	
Satisfied	29	27.4	34	24.6	
Educational level					.263*
≤ 9 years	25	23.6	33	23.9	
10-12 years	60	56.6	88	63.8	
≥ 13 years	21	19.8	17	12.3	
Living area					.198*
Urban	54	50.9	79	57.2	
Rural	52	49.1	59	42.8	
BMI (kg/m2)					.075*
< 18.5	4	3.8	11	8.0	
18.5-25	77	72.6	108	78.3	
≥ 25	25	23.6	19	13.8	
Evaluations of oral function	Median	IQR	Median	IQR	*P* value
Occlusal force	471	320, 628	418	289, 586	.062†
Occlusal units	5	3, 6	5	3, 6	.913†
Stimulated salivary flow rate (mL/min)	1.4	0.9, 2.1	1.4	0.9, 2.1	.554†
Mean probing pocket depth (mm)	3.0	2.6, 3.3	3.1	2.8, 3.6	.010†
Number of teeth	23	22, 24	23	21, 24	.078†
Energy intake (kcal/day)	2,056	1,664; 2,421	1,918	1,597; 2,338	.347†

*Chi-square test was used for categorical variables.
†Mann-Whitney U test was used for continuous variables.

Table 2 Comparison of Energy-Adjusted Food and Nutrient Intakes Between RPD Wearers and Nonwearers

	RPD nonwearers (n = 106)		RPD wearers (n = 138)			
Dietary intake	Mean	95% CI	Mean	95% CI	*P* value	% Difference*
Food						
Cereals (g/1,000 kcal)	207	195–219	201	191–212	0.506	-3.0
Vegetables (g/1,000 kcal)	161	145–177	184	170–198	0.035	12.5
Fish and shellfish (g/1,000 kcal)	56	50–62	62	57–67	0.175	9.7
Meat (g/1,000 kcal)	28	25–32	33	30–36	0.061	15.2
Nutrient						
n-3 fatty acid (% energy)	1.4	1.3–1.5	1.5	1.4–1.6	0.032	6.7
Calicium (mg/1,000 kcal)	334	313–355	383	363–402	0.001	12.8
Vitamin A (μg retinol equivalent/1,000 kcal)	435	379–491	525	475–575	0.020	17.1
Vitamin C (mg/1,000 kcal)	80.0	73.6–86.2	85.1	79.2–90.9	0.271	6.0
Vitamin E (mg/1,000 kcal)	4.3	4.1–4.5	4.5	4.3–4.7	0.135	4.4
Dietary fiber (g/1,000 kcal)	7.3	6.8–7.8	7.9	7.5–8.3	0.042	7.6

Analyses of covariance were conducted controlling for age, sex, SES, OF, OUs, SSFR, and PPD between RPD wearers and nonwearers.
*Mean for (RPD wearers – nonwearers) / RPD wearers × 100 (%)

The ANCOVA showed that intake of vegetables, n-3 fatty acids, calcium, vitamin A, and dietary fiber were significantly higher in RPD wearers when adjusted for age, sex, SES, oral function, and PPD (Table 2).

Discussion

RPD wearers ate more vegetables, n-3 fatty acids, calcium, vitamin A, and dietary fiber than did nonwearers. These nutrients are important for the prevention of cardiovascular disease and cancer. Attitudes toward health were not considered to be remarkably different between the two groups since their SES was not significantly different. Because the number of occlusal units, occlusal force, and salivary flow were not significantly different between the two groups, we suggest that RPDs play a different role in dietary intake. One possibility is that RPDs facilitate bolus formation by separating the oral vestibule and oral cavity proper,[5] allowing food particles to be carried onto the occlusal surface smoothly and effectively. This would enable RPD wearers to take in more foods considered to be difficult to chew than could nonwearers.

Conclusions

RPDs appear to be effective in improving dietary intake even in participants who have lost a small number of teeth.

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Literature Abstract

Loss of Teeth Opposing Implant-Supported Prostheses In The Posterior Mandible: A Retrospective Survey In Dental Clinics

It may be hypothesized that natural teeth opposing implant-supported prosthetic teeth are more likely to be lost because of increased loading. A natural tooth moves apically more than an implant under similar loads due to the presence of periodontal ligaments, which provide a cushioning effect. The aim of this retrospective study was to investigate the incidence of loss of natural teeth opposing implant-supported prosthetic teeth in the posterior mandible. Surveys were sent to 42 dentists in Japan for information on patients who have had implants placed on one side of the posterior mandible before December 2009. Natural teeth were divided into three groups: opposing teeth, control teeth, and other teeth. Data collected on 383 patients showed that 1.72% of opposing teeth, 1.84% of control teeth, and 0.98% of other teeth were lost during a mean observation period of 72 months post implant prosthesis placement. Opposing teeth loss was significantly higher than other teeth loss; however, no significant differences were found between opposing teeth loss and control teeth loss. This observation may be due to other teeth, such as the incisors, being generally more durable compared to molar teeth. It was concluded that implant-supported prosthesis in the posterior mandibular region are not considered to be a risk factor for opposing natural teeth loss. This study was limited by relatively short observation periods, and its authors suggest that future studies should include a longer-term observation period and also provide more details about pre-existing conditions like periodontal status, chewing patterns, and bruxism.

Yoshino K, Ito K, Kuroda M, Matsukubo T. *Int J Oral Maxillofac Implants* 2014;29:937–941. **References:** 17. **Reprints:** Dr Koichi Yoshino, Department of Epidemiology and Public Health, Tokyo Dental College, 1-2-2 Masago, Mihama-ku, Chiba 261-8502, Japan. Fax: +81-43-270-3748. Email: ko-yoshi@d8.dion.ne.jp—*Debbie P.M Hong, Singapore*