THE JOURNAL OF PROSTHETIC DENTISTRY

CLINICAL RESEARCH

Removable denture use, fit, and all-cause mortality in older adults with reduced occlusal support: The OHSAKA study

Tomoaki Mameno, DDS, PhD,[a] Naoko Otsuki, RN, PhD,[b] Satoko Takeuchi, DDS,[c] Ryohei Yamamoto, MD, PhD,[d] and Kazunori Ikebe, DDS, PhD[e]

ABSTRACT

Statement of problem. As the global population ages, tooth loss among older adults has become increasingly prevalent, impacting oral function and overall health. Although removable dentures have been used to improve masticatory function, the long-term effects of denture conditions on mortality are unclear.

Purpose. The purpose of this clinical study was to clarify the association between removable denture condition and the mortality rate in older adults with reduced occlusal support.

Material and methods. This longitudinal study analyzed survival data (up to 2022) for 186 893 individuals aged ≥75 years who underwent dental examinations through public healthcare services between 2018 and 2020. The participants were categorized into 10 groups (A1 to A3, B1 to B4, and C1 to C3) based on their occlusal support status using the Eichner index. Denture conditions were assessed by private practice dentists and classified into 3 categories: well-fitting, poorly fitting, and not used. Cox proportional hazards regression analyses were conducted to examine the association between denture conditions and mortality by considering the following control variables: age, sex, history of chronic diseases (hypertension, diabetes, hyperlipidemia, and dementia), smoking habits, and body mass index for the entire study population and within each of the B1 to B4 and C1 to C3 groups.

Results. Significantly higher hazard ratios (HRs) for mortality were observed with occlusal support deterioration, poorly fitting dentures, and nonusage, with the peak observed in the C3 group with no dentures. The HRs (with 95% confidence intervals) of well-fitting dentures were consistently the lowest across all groups as follows: 0.98 (0.90 to 1.06) in B1, 1.02 (0.95 to 1.10) in B2, 1.11 (1.03 to 1.19) in B3, 1.14 (1.07 to 1.22) in B4, 1.15 (1.05 to 1.26) in C1, 1.28 (1.21 to 1.37) in C2, and 1.58 (1.46 to 1.72) in C3, with the A1 to A3 group as the reference. Poorly fitting or no dentures were associated with increased HRs in the Eichner groups B3 to C3, compared with well-fitting dentures.

Conclusions. This large population-based cohort study found that well-fitting dentures were associated with lower mortality risk in older adults with reduced posterior occlusal support. Nonusage or poorly fitting dentures were associated with an increased risk of mortality as occlusal support deteriorated. (J Prosthet Dent 2025;133:1505-1511)

The aging population is increasing globally,[1] leading to a higher prevalence of reduced numbers of remaining teeth among older adults.[2] Tooth loss, a crucial factor affecting oral function in older adults, has been linked to different systemic health conditions, including malnutrition,[3] frailty,[4] cardiovascular diseases,[5] and mortality.[6]

A decrease in the number of posterior occlusal teeth can lead to diminished masticatory performance,[7] affecting the ability to maintain a varied diet.[8,9] Removable denture use has been established as a suitable intervention to restore occlusal support and improve masticatory function in individuals with missing teeth.[10,11] This, in turn, can contribute to maintaining general health and mitigating mortality risk. However, the long-term effects of denture conditions on health outcomes,

Supported by the Wider-Area Union for the Medical Care System for Elderly People in Osaka Prefecture and by Grants-in-Aid for Scientific Research (grant no. 24K02764) from the Japan Society for the Promotion of Science; the funder had no roles in design, methods, analysis, or preparation of this manuscript.
The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.
[a]Assistant Professor, Department of Removable Prosthodontics and Gerodontology, Osaka University Graduate School of Dentistry, Suita, Japan.
[b]Associate Professor, Department of Community-Based Integrated Care Science, School of Nursing, Osaka Metropolitan University, Abeno, Japan.
[c]PhD student, Department of Removable Prosthodontics and Gerodontology, Osaka University Graduate School of Dentistry, Suita, Japan.
[d]Professor, Health and Counseling Center, Osaka University, Toyonaka, Japan.
[e]Professor, Department of Removable Prosthodontics and Gerodontology, Osaka University Graduate School of Dentistry, Suita, Japan.

Clinical Implications

This population-based study revealed an association between removable denture condition and mortality among approximately 187 000 older adults. For those with decreased posterior occlusal support, well-fitting dentures can mitigate mortality rates. These findings underscore the importance of adequate denture care in maintaining the health and survival of older adults.

particularly mortality, remain an area of ongoing research.[12] Previous studies have yielded mixed results, with some suggesting a protective effect of denture use on mortality,[13,14] whereas others have found no significant association.[15] One of the challenges in interpreting the results of studies examining the relationship between denture use and mortality is that the role of dentures in functional recovery differs across various dental conditions, including edentulous patients who have lost all their teeth and partially edentulous patients who have lost some or most of their teeth. In addition, the degree of functional recovery varies depending on the fit of the dentures.[16] These factors complicate the interpretation of the findings.

This population-based cohort study aimed to clarify the association between removable denture conditions and mortality rates among older adults with reduced occlusal support in Japan. A large sample size of 186 893 individuals enabled a thorough investigation of the hypothesis that using poorly fitting dentures or a lack of denture use is associated with increased mortality risk, particularly in those with reduced posterior occlusal support.

MATERIAL AND METHODS

This longitudinal study was part of an ongoing large cohort study called the "Oral Health Screening to Assess Keys of Well Aging (OHSAKA)," which aimed to identify factors that contribute to healthy life expectancy in older adults. Details of the OHSAKA study have been described elsewhere.[17] Briefly, this study used data from dental examinations conducted as part of the public healthcare services. The eligible participants were 190 282 adults aged ≥75 years who had insurance in Osaka Prefecture, Japan and who underwent a dental examination at 4193 registered private dental clinics between April 2018 and March 2020. Individuals with missing data or fractured dentures were excluded from the study. All insurance and medical claims data were obtained from the National Health Insurance Database of Japan (Kokuho database: KDB). This database contains monthly medical claims data, including standardized codes for electronic claims processing as specified by the Ministry of Health, Labor, and Welfare, offering detailed information on prescriptions and medical procedures.

This study had been approved by the university's institutional review board (approval number 2022–2, R4–M2). Participants were informed about the research and their involvement through an opt-out consent process. They were provided with comprehensive information detailing the study's purpose, procedures, potential risks, and benefits through the research institution's website. The study followed the guidelines of the Strengthening the Reporting of Observational Studies in Epidemiology.[18]

The primary outcome was all-cause mortality. Each participant's vital status until March 2022 was obtained from the KDB. All-cause mortality was verified as the reason for loss of insurance eligibility. Survival time was calculated from the first dental examination to the date of death or last follow-up.

The condition of the dentures was set as the exposure. The number of teeth and denture conditions were examined by private practice dentists with the participants in a dental chair. The maximum number of teeth surveyed was 28, excluding third molars. The condition of the dentures was evaluated according to 4 categories: well-fitting, poorly fitting, fractured, and no dentures. To assess the significance of dentures based on dentition, the participants were grouped using the Eichner index.[19] This index categorizes dentition according to the number of occlusal contacts between natural teeth in the posterior occlusal support zones (POSZs), that is the 4 premolar and molar regions. It includes 3 main classes (A, B, and C) with 10 subgroups. Class A included individuals with occlusal contacts in all 4 POSZs; class B included those with contacts in 1 to 3 POSZs or only in the anterior region; and class C included individuals with no occlusal contacts. Figure 1 illustrates the detailed classification information. In this study, Eichner class A (A1 to A3 group), which retained all occlusal support in the molar region, was considered to have sufficient function with natural teeth and was set as the reference category. The target group comprised those in Eichner classes B or C, which were further subdivided according to the condition of their dentures. Individuals with fractured dentures were excluded from the analysis.

Hypertension, diabetes, hyperlipidemia, dementia, smoking habits, and body mass index (BMI) were evaluated as the covariates.[20–25] Medications prescribed during the 6 months after the dental examination were extracted from the KDB system according to the Anatomical Therapeutic Chemical Classification. The participants were classified as having a history of hypertension if they had been prescribed diuretics, beta-blockers, calcium channel blockers, or angiotensin receptor blockers or angiotensin converting enzyme inhibitors. Those prescribed antidiabetic drugs were classified as having a history of diabetes. Additionally, participants prescribed lipid-lowering drugs were considered to

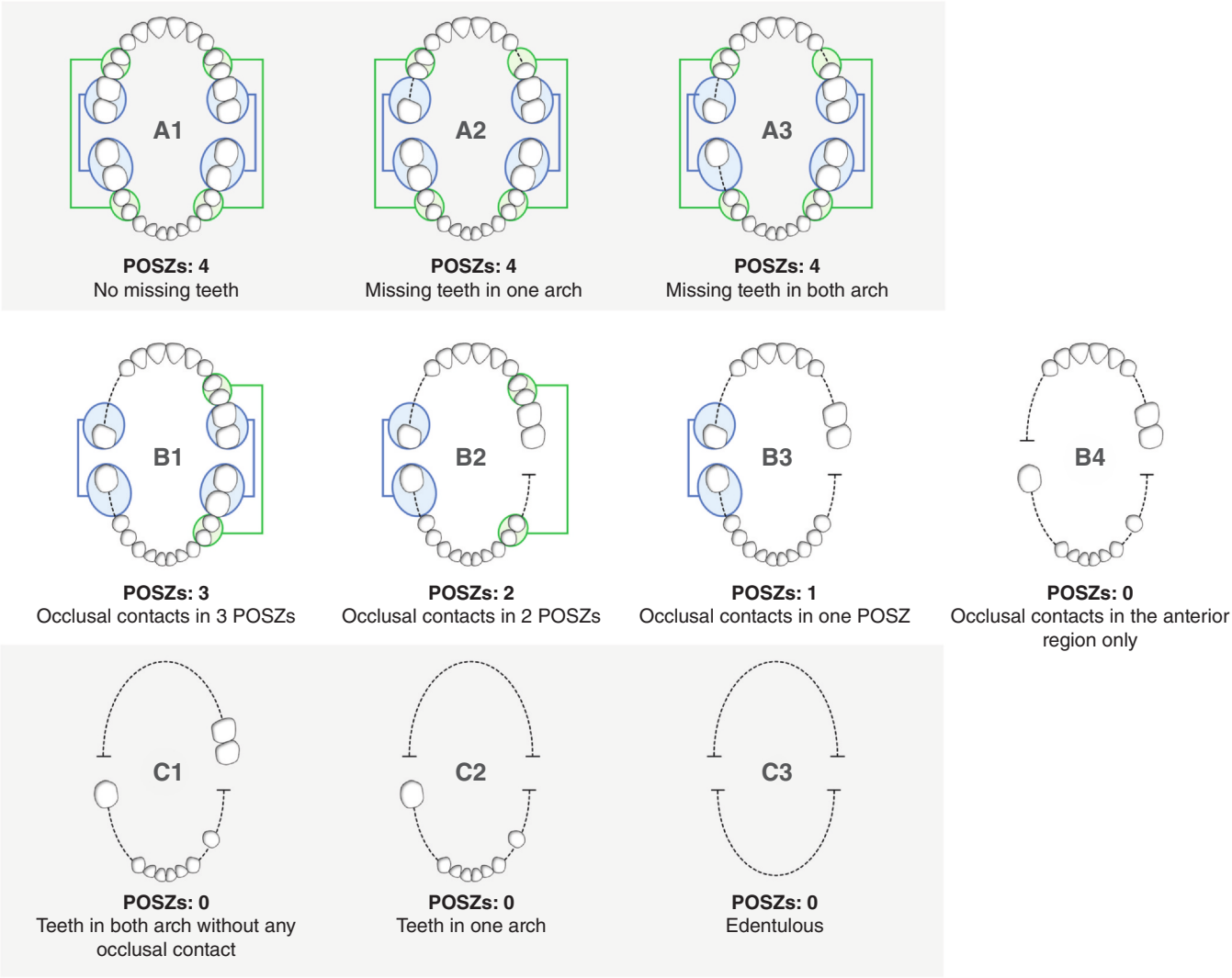

Figure 1. Eichner index and schematic representation. Eichner index evaluates antagonistic occlusal contacts in premolar and molar regions as posterior occlusal support zones (POSZs), indicated by pairs of shaded circles. These regions classified into 4 POSZs, with occlusal support status assessed based on contact within each zone.

have a history of hyperlipidemia, whereas those prescribed antidementia drugs were considered to have a history of dementia. The smoking habits (current, former, and never smokers) and BMI were investigated using a questionnaire. The participants were divided into 4 BMI categories according to the World Health Organization Asian classification: <18.5 kg/m^2 as underweight, 18.5 to 22.9 kg/m^2 as normal, 23 to 24.9 kg/m^2 as overweight, and ≥25 kg/m^2 as obese.[26]

The cumulative probability of incidence of all-cause mortality was estimated using the Kaplan–Meier method. Cox proportional hazards regression analysis was conducted to calculate the hazard ratios (HRs) and 95% confidence intervals (CIs) for mortality. In the Cox proportional hazards model, the denture condition, categorized by Eichner groups B1 to C3, was set as an explanatory variable, with the A1 to A3 group as the reference. The following demographic and confounding factors at baseline were included as control variables: age (year), sex (male or female), history of chronic disease (hypertension, diabetes, hyperlipidemia, and dementia), smoking habits (current, former, and never smokers), and BMI (underweight, normal, overweight, and obese). Additionally, stratified Cox proportional hazards regression analyses, with the denture condition as an explanatory variable, were conducted within each of the Eichner groups B1 to C3. Model performance was evaluated using the concordance index for each model.[27] Additionally, the Cox and Snell pseudo-R-squared was calculated using the log-likelihood values from a control model, which included only control variables, and a full model, which included denture condition and control variables, to assess the partial impact of denture condition on mortality.[28] All statistical analyses were performed

using the scikit-learn and lifeline libraries in a software program (Python version 3.9.5; Python Software Foundation) (Two-sided α=.05 for all analyses).

RESULTS

Among 190 282 older adults who underwent a dental examination between April 2018 and March 2020, 1398 with incomplete examination data and 1991 with fractured dentures were excluded. A total of 186 893 individuals were included in the final analysis. Descriptions of the participants' characteristics are presented in Table 1. The highest proportion of participants was found in group B1 (14.2%), followed by group A2 (13.7%). Mortality was observed in 15 955 (8.5%) individuals during a mean observation period of 1163.2 days. Figure 2 illustrates the Kaplan–Meier survival curve and 95% CIs for Eichner groups A1 to C3. The cumulative survival rate decreased with the severity of the Eichner classification.

Table 2 presents the cumulative survival rate categorized by denture condition in Eichner groups B1 to C3. In groups B1 and B2, the difference in survival rates based on the denture condition was relatively small, and these groups generally maintained high survival rates. In groups B3, B4, C1, C2, and C3, relatively low survival rates were observed in those with poorly fitting dentures or no dentures.

Table 1. Description of participant characteristics at baseline

		N	%
Age group, years			
	90–	6586	3.5
	85–89	24 290	13.0
	80–84	59 196	31.7
	75–79	96 821	51.8
Sex			
	Female	107 547	57.5
	Male	79 346	42.5
Eichner group			
	A1	15 948	8.5
	A2	25 665	13.7
	A3	17 634	9.4
	B1	26 520	14.2
	B2	23 934	12.8
	B3	18 991	10.2
	B4	20 766	11.1
	C1	8488	4.5
	C2	20 252	10.8
	C3	8695	4.7
Hypertension			
	Yes	112 404	60.1
Diabetes			
	Yes	27 594	14.8
Hyperlipidemia			
	Yes	69 548	37.2
Dementia			
	Yes	7565	4.0
Smoking habits			
	Current	13 314	7.1
	Former	53 192	28.5
	Never	120 387	64.4
Body mass index, kg/m^2			
	>25	36 039	19.3
	23–24.9	40 953	21.9
	18.5–22.9	93 593	50.1
	<18.5	16 308	8.7

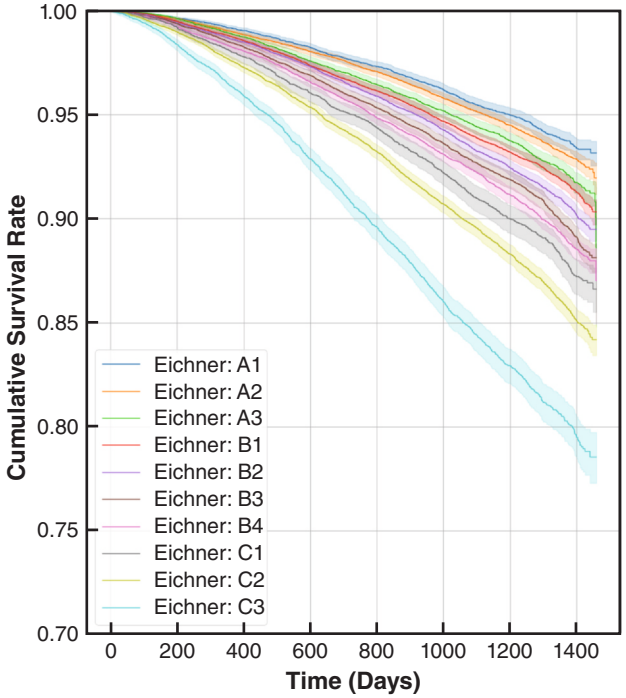

Figure 2. Kaplan–Meier survival curves based on Eichner groups. Shaded bands indicate 95% confidence intervals.

The results of the Cox proportional hazards regression analysis examining the association between denture condition and mortality within Eichner groups B1 to C3 are summarized in Table 3. This analysis revealed significantly higher HRs for mortality with occlusal support deterioration, poorly fitting dentures, and nonusage, except for group B1 with well-fitting or poorly fitting dentures and B2 with well-fitting dentures. The HRs (95% CI) of well-fitting dentures were consistently the lowest across all Eichner groups as follows: B1, HR=0.98 (0.90 to 1.06); B2, HR=1.02 (0.95 to 1.10); B3, HR=1.11 (1.03 to 1.19); B4, HR=1.14 (1.07 to 1.22); C1, HR=1.15 (1.05 to 1.26); C2, HR=1.28 (1.21 to 1.37); and C3, HR=1.58 (1.46 to 1.72), with the A1 to A3 group as the reference. Under all denture conditions, the HR of group C3 was higher than that of the other groups. Those using well-fitting dentures showed an HR comparable with those with better occlusal support conditions who used poorly fitting dentures or did not use dentures (For example, C1 with well-fitting dentures, HR=1.15; B1 with poorly fitting dentures, HR=1.16). The highest HR was observed in group C3 with poorly fitting dentures (HR=1.83). Additionally, in this model, being male; being underweight; being a current or past smoker; having a history of diabetes, hypertension, or dementia; and being older were risk factors for mortality. Conversely, being overweight, obese, or having hyperlipidemia were protective factors against mortality. The

Table 2. Life table for each denture condition categorized by Eichner groups B1 to C3

Eichner Group	Denture Condition	N	700 Days		1050 Days		1400 Days	
			Number at Risk	CSR (95% CI)	Number at Risk	CSR (95% CI)	Number at Risk	CSR (95% CI)
B1	Well-fit	10 586	10 189	96.9 (96.5–97.2)	7498	94.7 (94.2–95.1)	2308	92.0 (91.3–92.6)
	Poor-fit	1883	1807	96.5 (95.6–97.3)	1247	93.5 (92.3–94.6)	317	91.0 (89.3–92.5)
	No	12 779	12 262	96.6 (96.3–96.9)	8656	94.1 (93.7–94.5)	2457	90.8 (90.1–91.4)
B2	Well-fit	13 345	12 853	97.0 (96.7–97.3)	9462	94.5 (94.1–94.9)	3096	91.1 (90.5–91.7)
	Poor-fit	3165	3003	95.5 (94.7–96.2)	2029	92.3 (91.2–93.2)	568	88.4 (86.8–89.7)
	No	6480	6177	96.2 (95.7–96.7)	4212	93.1 (92.5–93.7)	1217	89.2 (88.3–90.2)
B3	Well-fit	12 430	11 885	96.4 (96.0–96.7)	8729	93.8 (93.3–94.2)	2830	90.0 (89.4–90.7)
	Poor-fit	3545	3355	95.3 (94.5–95.9)	2212	91.7 (90.7–92.6)	647	87.5 (86.1–88.9)
	No	2354	2217	95.3 (94.4–96.1)	1469	91.9 (90.7–93.0)	377	86.7 (84.7–88.4)
B4	Well-fit	14 022	13 364	96.2 (95.8–96.5)	9753	93.5 (93.1–93.9)	3240	89.3 (88.6–89.9)
	Poor-fit	4800	4511	94.8 (94.1–95.4)	2933	90.8 (89.9–91.6)	835	86.8 (85.6–87.9)
	No	1216	1138	94.8 (93.4–95.9)	714	91.5 (89.8–93.0)	190	87.6 (85.0–89.7)
C1	Well-fit	5326	5046	95.6 (95.0–96.1)	3642	92.4 (91.6–93.1)	1192	88.3 (87.2–89.2)
	Poor-fit	2642	2470	94.3 (93.3–95.1)	1679	90.0 (88.8–91.1)	459	85.1 (83.3–86.8)
	No	244	223	93.3 (89.3–95.9)	133	89.7 (84.8–93.1)	31	81.8 (74.2–87.4)
C2	Well-fit	12 720	11 959	94.9 (94.5–95.2)	8445	90.9 (90.4–91.4)	2746	86.4 (85.7–87.1)
	Poor-fit	6395	5927	93.5 (92.9–94.1)	3761	88.8 (88.0–89.6)	972	82.7 (81.5–83.9)
	No	819	750	92.7 (90.7–94.3)	565	88.1 (85.7–90.2)	176	83.6 (80.4–86.2)
C3	Well-fit	4527	4124	92.0 (91.1–92.7)	2746	86.4 (85.3–87.4)	795	80.6 (79.2–82.0)
	Poor-fit	3748	3340	90.2 (89.2–91.1)	2099	84.0 (82.8–85.2)	508	78.3 (76.7–80.0)
	No	332	297	90.3 (86.5–93.0)	231	82.2 (77.5–86.0)	87	76.5 (70.9–81.1)

CI, confidence interval; CSR, cumulative survival rate.

Table 3. Adjusted hazard ratios for mortality (with 95% confidence intervals) of each denture condition categorized by Eichner groups B1 to C3 with groups A1–3 as reference

	Well-fit	Poor-fit	No
A1–3	Reference		
B1	0.98 (0.90–1.06)	1.16 (0.98–1.38)	1.11 (1.04–1.20)*
B2	1.02 (0.95–1.10)	1.32 (1.17–1.49)*	1.24 (1.14–1.36)*
B3	1.11 (1.03–1.19)*	1.33 (1.19–1.48)*	1.39 (1.22–1.59)*
B4	1.14 (1.07–1.22)*	1.40 (1.28–1.54)*	1.48 (1.23–1.77)*
C1	1.15 (1.05–1.26)*	1.40 (1.25–1.57)*	1.48 (1.04–2.11)*
C2	1.28 (1.21–1.37)*	1.56 (1.45–1.68)*	1.51 (1.26–1.82)*
C3	1.58 (1.46–1.72)*	1.83 (1.68–1.99)*	1.79 (1.41–2.28)*

*P<.05. Adjusted hazard ratios were calculated using Cox proportional hazards model that included the following control variables: age (year), sex, history of chronic disease (hypertension, diabetes, hyperlipidemia, and dementia), smoking habits (current, former, and never smokers), and body mass index (underweight, normal, overweight, and obese).

Table 4. Summary of adjusted hazard ratios for mortality (with 95% confidence intervals) of each denture condition obtained from stratified Cox proportional hazards analyses conducted within each Eichner group B1 to C3

	Well-fit	Poor-fit	No
B1	Reference	1.00 (0.84–1.18)	0.96 (0.89–1.02)
B2	Reference	1.13 (1.01–1.27)*	1.07 (0.98–1.17)
B3	Reference	1.14 (1.02–1.27)*	1.19 (1.05–1.36)*
B4	Reference	1.20 (1.10–1.31)*	1.27 (1.06–1.52)*
C1	Reference	1.18 (1.06–1.32)*	1.25 (0.88–1.77)
C2	Reference	1.33 (1.24–1.43)*	1.29 (1.08–1.55)*
C3	Reference	1.56 (1.44–1.69)*	1.53 (1.21–1.94)*

* P<.05. Stratified Cox proportional hazards models included the following control variables: age (year), sex, history of chronic disease (hypertension, diabetes, hyperlipidemia, and dementia), smoking habits (current, former, and never smokers), and body mass index (underweight, normal, overweight, and obese).

concordance and Cox and Snell pseudo-R-squared were 0.73 and 0.05, respectively. The results for all variables in this analytical model are presented in Supplemental Table 1 (available online).

Table 4 presents the adjusted HRs for mortality of each denture condition derived from the stratified Cox proportional hazards regression analyses conducted within Eichner groups B1 to C3. Poorly fitting dentures were associated with increased HRs across all the Eichner groups, with the risk generally increasing from groups B1 to C3. For example, in group B1, the HR was 1.00 (95% CI: 0.84 to 1.18), which was equivalent to the reference group. In contrast, the HR for the C3 group was 1.56 (95% CI: 1.44 to 1.69), indicating a significant increase. Statistically significant increases in HRs were observed from groups B2 to C3. Nonusage of dentures also resulted in elevated HRs in most groups, particularly in group C3, where the HR was 1.53 (95% CI: 1.21 to 1.94), the highest observed. Statistically significant increases were noted in groups B3, B4, C2, and C3 (P<.05), whereas no significant increases were observed in groups B1 or C1 (P>.05). The results of the stratified regression analysis, including the adjusted variables, are presented in Supplemental Tables 2 to 8 (available online).

DISCUSSION

This population-based cohort study, which included 186 893 older Japanese adults aged ≥75 years, revealed that having fewer posterior occlusal supports, particularly being fully edentulous, is linked to an increased risk of mortality. The use of well-fitting dentures may mitigate these risks, especially in individuals with a severe loss of occlusal support.

The impact of denture use on mortality risk has been investigated. A population-based cohort study of 1246 individuals in the US revealed that the use of removable partial dentures may have long-term benefits in

reducing mortality among adults with nonfunctional dentition.[13] A community cohort study involving 5403 older Chinese individuals concluded that self-reported removable denture use can mitigate the adverse effects of tooth loss on all-cause and some cause-specific mortality.[14] Although this evidence is supported by survival analysis considering a multitude of observed confounders, the evaluation of removable denture use only considered whether dentures were used or not. However, it has been reported that the fit of dentures is related to the diversity of nutrient intake and quality of diet in older adults.[29,30] Assessing the fit of dentures is essential to understand their impact on mortality.

The present study revealed that decreased posterior occlusal support was associated with an increased risk of mortality, a risk that may be mitigated by the use of well-fitting removable dentures. Having few teeth has been associated with an increased risk of mortality,[6] as found in the present study. Posterior occlusal support of the remaining dentition was reported as a crucial predictor of reduced masticatory performance in a cross-sectional study that evaluated 1274 participants aged ≥60 years.[31] Additionally, a 5-year longitudinal study involving older adults in Japan found that impaired dentition, with fewer than 6 pairs of opposing natural or prosthetic teeth, might restrict vegetable intake.[32] Therefore, reduced occlusal support makes mastication difficult, leading to insufficient food intake, which contributes to an increased risk of mortality. In addition, the relationship between the use of well-fitting dentures and mortality is indirectly supported by the findings of previous studies. A cross-sectional study that comprehensively assessed relationships among food choices, nutrient intake, and oral health revealed that well-fitting dentures were associated with higher and more varied nutrient intakes, as well as greater dietary quality.[30] Another study revealed that older adults with reduced posterior occlusal contact who used poorly fitting dentures had a lower intake of vegetables and seafood, whereas those with well-fitting dentures had no significant differences in food intake compared with those with maintained occlusal contact.[29] Based on the results of the present study and previous reports, the risk of nutritional problems caused by tooth loss may be particularly elevated when lost teeth are not replaced or when the denture fit is inadequate. The concordance index for each model was 0.73, indicating good predictive performance.[33] However, the increase in the model's explanatory power after including the denture condition was slight (from 0.05 to 0.06), suggesting that the good performance of the models is largely influenced by the contributions of other covariates rather than being solely dependent on denture condition.

Strengths of the study included that dentists evaluated the number and position of teeth as well as the denture condition, ensuring high accuracy and reliability. Furthermore, the study was based on extensive dental examination data from adults aged ≥75 years in Osaka Prefecture, covering urban, suburban, and rural areas. This comprehensive and large dataset allowed for a detailed assessment of diverse dental patterns and minimized selection bias. Additionally, adjusting for overall health conditions enabled a thorough evaluation of mortality risk. Most of the covariates analyzed were confirmed as risk factors for mortality, consistent with the study hypotheses.[20–23,25] Regarding overweight and obesity, a higher BMI in older adults may indicate improved nutritional status and sufficient muscle reserves, potentially providing protective effects against certain chronic diseases.[20] Although hyperlipidemia is recognized as a risk factor for cardiovascular disease in middle-aged and older adults,[24] it was identified as a protective factor against mortality in the present study. This outcome may be influenced by dietary and exercise interventions, as well as medication use among individuals with a history of hyperlipidemia; however, this remains speculative. These methodological strengths contributed to a robust investigation of the relationship between occlusal support, denture conditions, and mortality. The authors are unaware of a previous study that investigated the association between denture conditions and mortality risk, stratified by the occlusal support status of the molar region, in a large population of older adults.

Limitations of the study included that the history of systemic diseases was determined based on the medication usage recorded in the KDB system over the past 6 months. Thus, individuals who were not receiving medications for the diseases during that period were considered to have no history of the disease. In addition, the fit of the dentures, as assessed by dentists, was qualitatively evaluated. Evaluating dentures based on their functional performance—such as masticatory performance, oral health-related quality of life, and patient satisfaction—would be desirable for obtaining further insights. Furthermore, periodontal disease and symptoms of temporomandibular disorders, both important aspects related to masticatory function,[34,35] were not evaluated in this study, leaving room for further investigation. Potential confounding factors that were not adjusted for remained unassessed. The relationships among posterior occlusal support, denture condition, and mortality may be influenced by unmeasured confounding factors such as social isolation. Tooth loss and forgoing dentures to replace missing teeth have been linked to decreased social interaction and isolation,[36] which, in turn, are associated with higher mortality risk among older adults.[37] However, there are currently no reports examining the association between denture conditions and mortality across diverse dental conditions using a large sample size. Therefore, the present findings can contribute significantly to the understanding of the importance of prosthodontic treatment for patients with missing teeth and inform public health policies aimed at enhancing the longevity and well-being of older adults.

CONCLUSIONS

Based on the findings of this clinical study, the following conclusions were drawn:

1. Well-fitting dentures were associated with lower mortality risk among older adults with decreased posterior occlusal support.
2. Nonusage or poorly fitting dentures were associated with an increased risk of mortality as occlusal support deteriorated.

APPENDIX A. SUPPORTING INFORMATION

Supplemental data associated with this article can be found in the online version at doi:10.1016/j.prosdent.2024.10.037.

REFERENCES

1. United Nations. Population division. Revision of world urbanization prospects; 2018. Available from: ⟨https://population.un.org/wup⟩. Accessed July 18, 2024.
2. Dibello V, Zupo R, Sardone R, et al. Oral frailty and its determinants in older age: A systematic review. *Lancet Healthy Longev*. 2021;2:e507–e520.
3. Zelig R, Goldstein S, Touger-Decker R, et al. Tooth loss and nutritional status in older adults: A systematic review and meta-analysis. *JDR Clin Trans Res*. 2022;7:4–15.
4. Iwasaki M, Yoshihara A, Sato M, et al. Dentition status and frailty in community-dwelling older adults: A 5-year prospective cohort study. *Geriatr Gerontol Int*. 2018;18:256–262.
5. Matsuyama Y, Jürges H, Listl S. Causal effect of tooth loss on cardiovascular diseases. *J Dent Res*. 2023;102:37–44.
6. Beukers NGFM, Su N, Loos BG, van der Heijden GJMG. Lower number of teeth is related to higher risks for ACVD and death-systematic review and meta-analyses of survival data. *Front Cardiovasc Med*. 2021;8:621626.
7. Higashi K, Hatta K, Mameno T, et al. The relationship between changes in occlusal support and masticatory performance using 6-year longitudinal data from the SONIC study. *J Dent*. 2023;139:104763.
8. Shiga H, Ishikawa A, Nakajima K, Tanaka A. Relationship between masticatory performance using a gummy jelly and food intake ability in Japanese complete denture wearers. *Odontology*. 2015;103:356–359.
9. Kagawa R, Ikebe K, Inomata C, et al. Effect of dental status and masticatory ability on decreased frequency of fruit and vegetable intake in elderly Japanese subjects. *Int J Prosthodont*. 2012;25:368–375.
10. Liang S, Zhang Q, Witter DJ, et al. Effects of removable dental prostheses on masticatory performance of subjects with shortened dental arches: A systematic review. *J Dent*. 2015;43:1185–1194.
11. Salazar S, Hasegawa Y, Kikuchi S, et al. The impact of a newly constructed removable denture on the objective and subjective masticatory function. *J Prosthodont Res*. 2021;65:346–352.
12. Gupta A, Felton DA, Jemt T, Koka S. Rehabilitation of edentulism and mortality: A systematic review. *J Prosthodont*. 2019;28:526–535.
13. Bashir NZ, Bernabé E. Removable partial dentures and mortality among partially edentulous adults. *J Dent*. 2022;126:104304.
14. Dai M, Song Q, Lin T, et al. Tooth loss, denture use, and all-cause and cause-specific mortality in older adults: A community cohort study. *Front Public Health*. 2023;11:1194054.
15. Dai J, Li A, Liu Y, et al. Denture wearing status, cardiovascular health profiles, and mortality in edentulous patients: A prospective study with a 27-year follow-up. *J Dent*. 2022;126:104287.
16. Garrett NR, Perez P, Elbert C, Kapur KK. Effects of improvements of poorly fitting dentures and new dentures on masticatory performance. *J Prosthet Dent*. 1996;75:269–275.
17. Mameno T, Otsuki N, Wada M, et al. Association between posterior occlusal support and tooth loss in a population-based cohort: The OHSAKA study. *J Dent*. 2024;148:105144.
18. von Elm E, Altman DG, Egger M, et al. STROBE Initiative. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: Guidelines for reporting observational studies. *BMJ*. 2007;335:806–808.
19. Eichner K. [Renewed examination of the group classification of partially edentulous arches by Eichner and application advices for studies on morbidity statistics]. *Stomatol DDR*. 1990;40:321–325.
20. Dramé M, Godaert L. The obesity paradox and mortality in older adults: A systematic review. *Nutrients*. 2023;15:1780.
21. Gellert C, Schöttker B, Brenner H. Smoking and all-cause mortality in older people: Systematic review and meta-analysis. *Arch Intern Med*. 2012;172:837–844.
22. Liang CS, Li DJ, Yang FC, et al. Mortality rates in Alzheimer's disease and non-Alzheimer's dementias: A systematic review and meta-analysis. *Lancet Healthy Longev*. 2021;2:e479–e488.
23. Barnett KN, McMurdo ME, Ogston SA, et al. Mortality in people diagnosed with type 2 diabetes at an older age: A systematic review. *Age Ageing*. 2006;35:463–468.
24. Alloubani A, Nimer R, Samara R. Relationship between hyperlipidemia, cardiovascular disease and stroke: A systematic review. *Curr Cardiol Rev*. 2021;17:e051121189015.
25. Ettehad D, Emdin CA, Kiran A, et al. Blood pressure lowering for prevention of cardiovascular disease and death: A systematic review and meta-analysis. *Lancet*. 2016;387:957–967.
26. WHO Expert Consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *Lancet*. 2004;363:157–163.
27. Cox DR. Regression models and life-tables. *J R Stat Soc B (Methodol)*. 1972;34:187–202.
28. Harrell Jr FE, Lee KL, Califf RM, et al. Regression modelling strategies for improved prognostic prediction. *Stat Med*. 1984;3:143–152.
29. Iwasaki M, Taylor GW, Manz MC, et al. Oral health status: relationship to nutrient and food intake among 80-year-old Japanese adults. *Community Dent Oral Epidemiol*. 2014;42:441–450.
30. Marshall TA, Warren JJ, Hand JS, et al. Oral health, nutrient intake and dietary quality in the very old. *J Am Dent Assoc*. 2002;133:1369–1379.
31. Ikebe K, Matsuda K, Kagawa R, et al. Masticatory performance in older subjects with varying degrees of tooth loss. *J Dent*. 2012;40:71–76.
32. Iwasaki M, Yoshihara A, Ogawa H, et al. Longitudinal association of dentition status with dietary intake in Japanese adults aged 75 to 80 years. *J Oral Rehabil*. 2016;43:737–744.
33. Büttner S, Galjart B, Beumer BR, et al. Quality and performance of validated prognostic models for survival after resection of intrahepatic cholangiocarcinoma: A systematic review and meta-analysis. *HPB (Oxford)*. 2021;23:25–36.
34. Fan Y, Shu X, Leung KCM, Lo ECM. Association between masticatory performance and oral conditions in adults: A systematic review and meta-analysis. *J Dent*. 2023;129:104395.
35. Santana-Penín U, Santana-Mora U, López-Solache A, et al. Remodeling dental anatomy vs sham therapy for chronic temporomandibular disorders. A placebo-controlled randomized clinical trial. *Ann Anat*. 2023;250:152117.
36. Abbas H, Aida J, Cooray U, et al. Does remaining teeth and dental prosthesis associate with social isolation? A six-year longitudinal study from the Japan Gerontological Evaluation Study (JAGES). *Community Dent Oral Epidemiol*. 2023;51:345–354.
37. Holt-Lunstad J, Smith TB, Baker M, et al. Loneliness and social isolation as risk factors for mortality: A meta-analytic review. *Perspect Psychol Sci*. 2015;10:227–237.

Corresponding author:
Prof Tomoaki Mameno
Department of Removable Prosthodontics and Gerodontology
Osaka University Graduate School of Dentistry
1–8 Yamadaoka
Suita, Osaka 565–0871
JAPAN
Email: mameno.tomoaki.dent@osaka-u.ac.jp

Acknowledgments
The authors would like to thank the members of the Osaka Dental Association for their invaluable cooperation and assistance with the data collection.

CRediT authorship contribution statement
Tomoaki Mameno: Conceptualization, Formal analysis, Writing – original draft, Visualization. **Naoko Otsuki**: Investigation, Data curation, Writing – review and editing. **Satoko Takeuchi**: Data curation, Formal analysis, Validation. **Ryohei Yamamoto**: Methodology, Project administration, Funding acquisition, Writing – review and editing. **Kazunori Ikebe**: Conceptualization, Project administration, Supervision, Writing – review and editing.

Copyright © 2024 The Authors. Published by Elsevier Inc. on behalf of the Editorial Council of *The Journal of Prosthetic Dentistry*. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).

https://doi.org/10.1016/j.prosdent.2024.10.037