Evaluation of occlusal status of Japanese adults based on functional tooth units

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ABSTRACT

Objectives: Although extensive national oral health data on dental caries and periodontal diseases in Japan are available, few studies have assessed the occlusal status of the Japanese population, and none are based on national survey data. The presence and prosthetic conditions of the molar region are important for masticatory function, and the functional tooth unit (FTU) approach can be used to evaluate the occlusal status. Thus, using the national oral health survey data, this study investigated the occlusal status of the Japanese population using FTU.

Methods: Overall, 3,605 adults (aged ≥20 years) who participated in the 2011 Japanese national oral health survey were included. FTUs were used as indices for evaluating the occlusal status. FTUs were calculated according to sex, age group, and the number of teeth present, and their associations were further analysed.

Results: The number of teeth present, posterior teeth, and FTUs decreased with age in both men and women. In the age group of those ≥60 years, all only natural teeth-FTU (n-FTU) and natural teeth and artificial teeth from fixed prostheses or implant-supported FTU (nif-FTU) scores were <8. The total-FTU scores of all age groups, except the 60-69 and 70-79 years age groups, were >10.

Conclusion: This is the first study to use FTUs and national oral health survey data to investigate the occlusal status in the Japanese population. People aged ≥60 years who have low n-FTU or natural teeth and artificial teeth from fixed prostheses or implant-supported FTU scores or those aged 60-70 years who have the lowest total-FTU scores require careful evaluation of masticatory performance.

Introduction

The national oral health survey has been conducted every 5-6 years in Japan since 1957. These surveys report the dental, prosthetic, and gingival status and malocclusion in all age groups in the Japanese population. Thus, many studies on dental caries and periodontal diseases in the Japanese population have been conducted based on these reports. The results of these surveys have suggested that many individuals in older age groups have missing teeth and a higher rate of use of prostheses. However, these studies have not investigated the occlusal status, which is strongly associated with masticatory ability.

Many indices, such as the Kennedy classification and Eichner index, are used to evaluate occlusal status. These indices are useful clinical classifications for revealing the exact prosthetic requirements and design of dentures for individual patients. However, the occlusal status of molars cannot be easily summarised with these indices. Hence, it is difficult to use them for the classification of prosthetic treatment needs or chewing function in a community.

The functional tooth unit (FTU) is an index that defines pairs of opposing teeth. The occlusal status can be easily computed using FTUs based on the presence or absence of molars and premolars. Previous studies have reported that the FTU is associated with nutrition and various health
problems. In particular, the risk of malnutrition is higher in elderly people with low FTU scores and people requiring long-term care, and low FTU scores affect health conditions such as obesity in Japanese people. However, few studies have investigated the occlusal status of the Japanese population using national survey data, despite the importance of evaluating the occlusal status and considering countermeasures. Thus far, in Japan, the number of teeth, periodontal disease, and dental caries have been investigated according to age, and the specific target in each age group has been set in Healthy Japan 21. In Healthy Japan 21, the goals of nutrition and obesity, which are strongly related to the occlusal condition, were set. However, the clinical occlusal condition of the Japanese population has not been investigated by chronological age and sex, and the problem has not been addressed. In Japan, FTU scores have been used to evaluate the oral function and masticatory efficiency of a community of people in a specific area. In those studies, lower masticatory function has been reported in individuals with all only natural-teeth (n-FTU) and natural teeth and artificial teeth from fixed prostheses or implant-supported FTU (nif-FTU) scores <8 or total-FTU scores <10. In addition, evaluating the occlusal condition by age group is important to understand the problems of the entire population. According to previous studies, FTU scores decrease in individuals aged 50-59 years. It is important to investigate the occlusal status by age and sex in the entire Japanese population to understand the problem because it often shows different patterns for specific areas as well as the entire country.

This study aimed to clarify the occlusal status, which has not been previously investigated in Japan, by evaluating the occlusal status using FTU in the Japanese population according to sex and chronological age. This study provides a more complete picture of the oral health needs of the Japanese population and analyse their potential prosthodontic treatment requirements, making it possible to provide basic data that can be compared internationally with regard to future national goals.

**Methods**

**Subjects**

We included Japanese residents who participated in the Japanese national oral health survey in 2011. Some aspects of oral health status in Japan have been assessed at the national level using reports from the Survey of Dental Diseases (SDD). SDD is conducted every 5-6 years since 1957. We obtained SDD data for 2011 from the Ministry of Health, Labour and Welfare with permission. SDD uses a hierarchized 2-stage cluster sample design to obtain a nationally representative sample of the noninstitutionalised Japanese population. The sampling frame is a list of the enumeration areas of all residential censuses stratified into 47 prefectures. Each population survey area consisted of approximately 50 households. Ultimately, 150-unit blocks were extracted from each prefecture. These data are for Japanese people aged at least 1 year; the data set in 2011 comprised 4253 people (1812 men and 2441 women). For this study, we included subjects aged ≥20 years. Our analysis, therefore, included 3605 adults (1485 men and 2120 women), with a mean age of 58.3 ± 17.0 years.

For this study, informed consent was not required, and ethical approval was not necessary as the data for this study were obtained from national surveys as per the Japanese ethical guidelines for medical and health research involving human subjects.

**Parameters investigated**

For the national survey, the dental examination was conducted with a dental mirror and a World Health Organization (WHO)-type periodontal probe. Dental status was examined visually and by tactile inspection. All examiners received calibration training using the criteria manual based on the WHO oral health examination methods.

For this study, data on demographic and clinical characteristics including sex, age, and the condition of each tooth were obtained from the national oral survey conducted in November 2011. Patients were divided into different age groups (20-29, 30-39, 40-49, 50-59, 60-69, 70-79, and ≥80 years). The number of teeth present, posterior teeth, and FTUs were calculated based on the original dental examination chart, excluding the third molars.

The FTUs were defined as pairs of opposing natural teeth (sound teeth, restored teeth, and decayed teeth with preserved tooth crown), artificial teeth that were fixed (bridge pontics) or implant supported, and removable prostheses. Missing teeth and decayed teeth with roots were defined as not functional. Two premolars that opposed each other were defined as 1 FTU, and 2 molars that opposed each other were defined as 2 FTUs. Therefore, for a person with a complete dentition (third molars excluded), the highest attainable score was 12 FTUs. Based on tooth composition, the FTUs were classified as n-FTUs, nif-FTUs, and complete FTUs (natural teeth, artificial teeth, and removable prostheses: total-FTUs).

**Statistical analysis**

One-way analysis of variance was used to detect any significant differences in the mean number of total teeth present, posterior teeth, and FTUs (n-FTUs, nif-FTUs, and total-FTUs) between sexes and among the different age groups. The Jonckheeere–Terpstra test was performed to determine whether a particular trend was present. A P value of <.05 was considered statistically significant. SPSS 20.0J software package (SPSS Japan) was used for analysis.

**Results**

**Number of teeth present and number of posterior teeth by sex and age group**

Table 1 shows the mean number of posterior teeth and total teeth by sex and age group. Men had a higher overall number of teeth present and had more posterior teeth than women in the 20-29 and ≥80 age groups. However, no difference was observed between men and women in the other age groups. In both men and women, the number of posterior teeth and
and the total-FTU scores were higher in the younger age groups than in the older age groups. In the women. However, no significant differences were observed in the 60- to 79-years age group.

Table 2 shows the mean FTU scores (n-FTUs, nif-FTUs, and total-FTUs) by sex and age group. All 3 types of FTUs were higher in the younger age groups than in the older age groups in both sexes (P value for trend <.001).

In the 20- to 29-years age group, men had significantly higher FTU scores (n-FTUs, nif-FTUs, and total-FTUs) than women. However, no significant differences were observed between men and women in the other age groups. In the ≥60 years age groups, all n-FTU and nif-FTU scores were <8, and the total-FTU scores were >10 in all age groups, except in the 60- to 79-years age group.

### Discussion

This is the first study to use FTUs and national oral health survey data to investigate the occlusal status of the Japanese population. We observed that the number of natural teeth present, n-FTU scores, and nif-FTU scores had the highest values in the 20- to 29-years age group and the lowest values in the ≥80 years age group. These scores decreased with age in both men and women. In particular, in the ≥60 years age groups, both n-FTUs and nif-FTU scores were >8. However, the lowest total-FTU scores were in the 60- to 69- and 70- to 79-years age groups (score <10).

The results of this study indicate that elderly people had greater tooth loss and that their missing teeth were replaced with removable prostheses. This may be attributed to the Japanese public health insurance system. In Japan, the universal health insurance system for the entire population was established in 1961. It covers almost all medical and dental treatments as well as any pharmacy care needed by the population. People can receive restorative, prosthetic, and oral surgery treatment at a relatively low cost, and the same fee is applied throughout the nation. This system allows elderly people who have lost their natural teeth to receive prosthetic treatment, and their functional occlusal status appears to be better than that of people in other countries. Compared with elderly people in other countries, elderly Japanese people in this study had a higher number of teeth and FTU scores. However, despite such a positive situation in Japan, the n-FTU and nif-FTU scores in the ≥60 years age groups were <8. In addition, the total-FTU in the 60 -to 69- and 70- to 79-years age groups (score <10).

### Table 1 – Mean number of total and posterior teeth by age and sex.

| Age group (years) | Total |   | Men |   | Women |   | P value |
|------------------|-------|---|-----|---|-------|---|---------|
|                  | N     | Mean | SD  | n  | Mean | SD  |         |
| Present teeth    |       |      |     |    |       |     |         |
| 20-29            | 211   | 25.72 | 2.12 | 77 | 27.71 | 0.89 |  <.001 |
| 30-39            | 464   | 27.34 | 1.32 | 177 | 27.02 | 1.18 |  <.001 |
| 40-49            | 437   | 26.64 | 3.00 | 157 | 26.43 | 3.64 |  .265  |
| 50-59            | 543   | 24.48 | 4.83 | 213 | 24.14 | 5.12 |  .195  |
| 60-69            | 835   | 21.46 | 7.13 | 354 | 21.42 | 7.47 |  .871  |
| 70-79            | 784   | 16.26 | 9.47 | 365 | 16.17 | 9.75 |  .793  |
| ≥80              | 331   | 10.72 | 9.43 | 142 | 12.00 | 9.59 |  .032  |
| P value for trend|       |      |     |    |       |     | <.001   |
| Posterior teeth  |       |      |     |    |       |     |         |
| 20-29            | 211   | 15.59 | 1.10 | 77 | 15.78 | 0.87 |  <.001 |
| 30-39            | 464   | 15.42 | 1.20 | 177 | 15.38 | 1.23 |  <.001 |
| 40-49            | 437   | 14.93 | 2.11 | 157 | 14.89 | 2.33 |  <.001 |
| 50-59            | 543   | 13.19 | 3.53 | 213 | 12.97 | 3.73 |  <.001 |
| 60-69            | 835   | 11.12 | 4.53 | 354 | 11.19 | 4.58 |  <.001 |
| 70-79            | 784   | 8.20  | 5.45 | 365 | 8.34  | 5.56 |  <.001 |
| ≥80              | 331   | 5.08  | 5.09 | 142 | 5.88  | 5.22 |  <.001 |

SD = standard deviation.
premolar region for orthodontic reasons. In another study, women in their 20s had more tooth extractions than men and 4 times more orthodontic tooth extractions than men. However, the number of males (211 people) in this study was small, and the standard deviation was also small. It was also possible that younger men with particularly good oral conditions were more likely to have participated in this study. In the ≥80 years age group, women had a lower number of teeth than men, but no significant difference in the FTU scores was observed. The standard deviation of the mean values of the present teeth in elderly people was large, suggesting that there may be considerable variation in the presence of teeth in elderly people. However, there were few differences in total-FTU scores between the prosthetic procedures performed. There is the possibility that older Japanese women receive prosthetic treatment and maintain occlusion better than men with a large number of missing teeth.

There is a limitation to the evaluation of occlusal status in this study. The FTU index used in this study was based only on the presence or absence of maxillary-mandibular molar and premolar pairs, and this does not indicate the clinical diagnosis of the presence or absence of direct occlusal contact. The FTU is used for the self-assessment of the occlusion status, and it is an index of masticatory ability. Therefore, in epidemiological surveys of a large number of people, the FTU is a useful index to assess the chewing ability and occlusion status. It is important to appropriately use both the FTU and other classifications of occlusion, such as the Kennedy classification and Eichner index, to evaluate the clinical occlusion status and prosthetic needs of each patient. Moreover, further research is needed to investigate the association between FTUs and other occlusal evaluations in the Japanese population. There is also a limitation in the sample size. The number of subjects in this study was relatively small (n = 3605), and there is a concern that they may not sufficiently represent the Japanese population. However, as described in the Methods section, the approach to selecting samples was precise, and hence, the included participants can be considered to represent the entire Japanese population. In addition, this study is a cross-sectional survey, and a comparison of occlusal status in longitudinal studies is necessary. In addition, inadequate clinical calibration for the examiner could be cited as a limitation. There were no calibration data or intrareliability or inter-reliability information. However, the study was performed using a strict manual based on the WHO oral health examination methods. In addition, biases in health outcomes due to inadequate calibration are considered to result in nondifferential misclassification.

Conclusion

This study revealed the detailed characteristics of the occlusal status of the Japanese population. Japanese people maintained good occlusal status, even during old age (≥80 years).
by replacing missing teeth with removable prostheses. However, people aged ≥60 years who have low n-FTU or nif-FTU scores or people in their 60s-70s who have the lowest total-FTU scores require careful masticatory evaluation.

The findings of this study should help in the planning of future oral health measures and the development of guidelines for oral care as the needs of the Japanese population change. In Healthy Japan 21, the Ministry of Health, Labour and Welfare of Japan has included improved goals for dental caries, periodontal disease, and the number of teeth for the Japanese people. Data on the occlusal status of the Japanese population are scarce. Therefore, in the future it is important to incorporate the occlusal status using FTUs into future national dental surveys.

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Conflict of interest
The authors declare that they have no conflicts of interest.

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Supplementary materials
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