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# A retrospective analysis of the prevalence of dental diseases in patients with digestive system cancers

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**Abstract**

The relationship between dental diseases and the prevalence of digestive system cancers remains unclear. The aim of the present study was to examine the prevalence of dental diseases in patients treated for digestive system cancers.

The medical and dental records of patients treated for digestive system cancers were retrospectively reviewed, and the results obtained (decayed/filled/missing teeth [DMFT] indices and community periodontal index [CPI] codes) were compared with data from the national survey of dental diseases in order to investigate the relationship between oral health and digestive system cancers.

DMFT, D, and F indices were significantly lower, while the M index was slightly higher in digestive system cancer patients than in the national survey. The proportions of individuals with more than 20 residual teeth and denture wearers were significantly lower in cancer patients than in the national survey. The prevalence of periodontitis (CPI codes 3 and 4) and severe periodontitis (CPI code 4) were significantly higher in cancer patients than in the national survey.

The present results showed that digestive system cancers were closely associated with multi-tooth loss and/or a low denture-wearing rate. The prevalence of severe periodontitis was also found to be higher in cancer patients. These results suggest that periodontitis and associated multi-tooth loss play a potential role in digestive system cancers.

**Abbreviation:** CPI = community periodontal index.

**Keywords:** digestive system diseases, DMFT indices, oral diseases, periodontitis

## 1. Introduction

The Surgeon General's report on oral health in America identified a "silent epidemic" of dental and oral diseases in the general population.[1] Oral health has a profound effect on general health. Dental and oral diseases have been implicated in several systemic diseases, including cardiovascular disease, diabetes mellitus, chronic obstructive pulmonary disease, endocarditis, and bacteremia. The oral cavity is a part of the gastrointestinal system, and previous studies demonstrated the influence of oral health conditions on the onset of gastrointestinal malignancies.[2–10] Patients with digestive system diseases have often been assumed to have more dental treatment needs than the general population. However, these assumptions have not yet been verified. The relationship between DMFT indices and the prevalence of digestive system cancers remains unclear.

Therefore, the aim of the present study was to investigate the prevalence of dental diseases in patients with digestive system cancers. Regarding the measurement of oral health conditions, the prevalence and distribution of caries and periodontal diseases are generally reported using indices with a numerical expression of oral health conditions or the degree of pathological involvement.[11–13] The most commonly used indicators are the decayed/missing/filled surface and decayed/filled/missing teeth (DMFT) indices.[14] Therefore, in the present study, DMFT indices were initially examined in digestive system cancer patients to assess the relationship between dental diseases and digestive system cancers. The prevalence of periodontitis was also investigated to identify the cause of missing teeth.

## 2. Methods

### 2.1. Assessment of DMFT in cancer patients

The study protocol was approved by the Ethics Committee of Shinshu University School of Medicine. The medical and dental records of 335 patients treated for digestive system cancers and who received perioperative oral management in Shinshu University Hospital between January 2012 and December 2013 were retrospectively reviewed. Each patient was subjected to oral and dental examinations according to the method of the Japanese National Survey of Dental Diseases by trained dentists. All examinations were conducted using a plane dental mirror and explorer using sunlight or a flashlight. However, the explorer was only used to clean the tooth surface as necessary and not to probe teeth or tooth surfaces. In order to evaluate the prevalence of dental

Editor: Kumpol Aiempanakit.

This study was approved by the Committee on Medical Research of Shinshu University and Nagano Municipal Hospital.

The authors declare that they have no conflicts of interest.

Supplemental Digital Content is available for this article.

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Medicine (2019) 98:13(e14771)

Received: 27 September 2018 / Received in final form: 21 December 2018 / Accepted: 10 February 2019

http://dx.doi.org/10.1097/MD.0000000000014771

diseases, DMFT indices were recorded. Since 1938, DMF indices became a relevant tool for monitoring the distribution of dental caries; it was applied by the World Health Organization (WHO) in their assessment of oral health, reflecting the intensity or frequency of dental caries.[15] Additionally, the use of dentures was verified.

### 2.2. Assessment of periodontitis in cancer patients

The study protocol was approved by the Ethics Committee of Nagano Municipal Hospital. The medical and dental records of 230 patients treated for digestive system cancers and who received perioperative oral management in Nagano Municipal Hospital in 2017 were retrospectively reviewed. Periodontal pocket depths were measured using standard WHO probes and the presence of periodontitis was assessed according to the criteria of the WHO community periodontal index (CPI) criteria.[16]

### 2.3. Statistical analysis

The results of dental examinations were compared with the closest data in the Japanese National Survey of Dental Disease. Data, including DMFT indices and denture wearers, were compared with data in the Japanese National Survey of Dental Diseases (2011),[17] while the prevalence of periodontitis was compared with that of 2016.[18] The Japanese National Survey of Dental Diseases has been conducted every 5 years. Statistical analyses, including the Mann–Whitney *U* test, chi-squared test, and Dunnett multiple comparison test, were performed using the StatView software package for Macintosh (SAS Institute, Inc, NC). All *P*-values of $<.05$ were considered to be significant.

## 3. Results

### 3.1. Assessment of DMFT in cancer patients

The characteristics of patients with digestive system cancers and a sample of the Japanese National Survey of Dental Diseases in 2011 were shown in Table 1. Among the 332 patients treated for digestive system cancers at our hospital, 115 (34.6%) were women and 217 (65.4%) men with a mean age of $70.0 \pm 5.02$ years. The most susceptible age was in the 6th and 7th decades of life and approximately 70% of digestive cancer patients were distributed in these age groups. Regarding the primary sites of digestive system cancers, 83 (24.5%) cases were the stomach, 79 (25.6%) the small/large bowel, and 78 (24.2%) the liver (Supplemental Table 1, http://links.lww.com/MD/C890).

The results of dental examinations (DMFT indices and the rate of denture wearers) in each age group of digestive cancer patients were shown in Table 2. Average DMFT was $18.68 \pm 7.08$, with the D index (no. of decayed teeth) $1.17 \pm 1.94$, M index (no. of missing teeth) $9.72 \pm 9.07$, and F index (no. of filled teeth) $8.99 \pm 5.54$. The DMFT and M indices increased with advancing age, while the F index decreased. The D index was highest in the 7th decade of life. The rate of denture wearers was 34.8% in all cancer patients, and increased with advancing age.

**Table 1**

**Gender and age distribution of the patients group and the sample of Japanese National Survey of Dental Diseases in 2011.**

| Total (man:woman) | Patients group 332 (217:115) | Control (National Survey 2011) 2162 (932:1230) |
|---|---|---|
| Age group | | |
| <10 | 0 | 210 (109:101) |
| 10–19 | 1 (0:1) | 283 (141:142) |
| 20–29 | 1 (1:0) | 211 (134:77) |
| 30–39 | 6 (5:1) | 464 (177:287) |
| 40–49 | 12 (7:5) | 437 (280:157) |
| 50–59 | 45 (25:20) | 543 (330:213) |
| 60–69 | 108 (82:26) | 835 (481:354) |
| 70–79 | 127 (81:46) | 784 (419:365) |
| 80 =< | 44 (28:16) | 331 (189:142) |

The results on DMFT indices were compared with data in the national survey. To control for differences in age distribution, data from patients aged 60 to 79 years, the most susceptible age for digestive system cancers, were selected and compared (Table 3). DMFT, D, and F indices were significantly lower in cancer patients than in the national survey (DMFT; 18.93 vs 20.13, D index; 0.55 vs 0.98, F index; 8.32 vs 10.10, respectively: the Student *t* test, $P < .01$). The number of missing teeth was slightly higher in cancer patients (10.06 vs 9.04, $P = .08$). A comparison of DMFT indices among patients with different cancer sites was shown in Supplemental Table 2, http://links.lww.com/MD/C890. No significant differences were observed among these patients.

The proportion of patients with less than 20 residual teeth was higher among cancer patients than in the national survey (48.1 vs 37.3%, the chi-squared test, $P < .01$; Table 4). This difference was significant among patients older than 60 years (36.1 vs 25.7%), but not among those with different cancer sites (Table 5).

The proportion of denture wearers was significantly lower among cancer patients than in the national survey (34.8 vs 52.9%, the chi-squared test, $P < .01$; Table 6). The significance of this difference was greater in patients older than 70 years (40.4 vs 70.0%), but not among those with cancer sites (Table 7).

**Table 2**

**The DMFT indices and rate of denture wearer of each age group.**

| | | DMFT | Decayed teeth | Missing teeth | Filling teeth | |
|---|---|---|---|---|---|---|
| | (n) | Mean ± SD (min–max) | Mean ± SD of number of teeth (min–max) | | | Denture wearer (%) |
| All | (332) | 18.68 ± 7.08 (0–28) | 1.17 ± 1.94 (0–10) | 9.72 ± 9.07 (0–28) | 8.99 ± 5.54 (0–25) | 34.8% |
| Age group | | | | | | |
| <40 | (8) | 11.50 ± 6.26 (0–19) | 0.50 ± 0.50 (0–1) | 0 | 11.25 ± 6.08 (0–19) | 0% |
| 40–49 | (12) | 12.75 ± 4.04 (8–21) | 1.00 ± 0.71 (0–2) | 1.83 ± 1.46 (0–5) | 10.58 ± 3.59 (6–16) | 11.1% |
| 50–59 | (45) | 16.04 ± 6.15 (3–28) | 1.09 ± 1.50 (0–6) | 4.51 ± 6.81 (0–27) | 11.51 ± 5.01 (1–19) | 14.8% |
| 60–69 | (108) | 17.77 ± 6.75 (1–28) | 1.82 ± 2.64 (0–10) | 8.03 ± 7.31 (0–28) | 9.22 ± 5.28 (0–20) | 28.0% |
| 70–79 | (127) | 19.87 ± 6.92 (0–28) | 0.71 ± 1.23 (0–5) | 11.78 ± 8.85 (1–28) | 8.53 ± 5.54 (0–25) | 40.4% |
| 80 =< | (32) | 24.81 ± 5.02 (0–28) | 0.86 ± 1.51 (0–4) | 19.97 ± 8.96 (0–28) | 4.93 ± 5.08 (0–15) | 70.4% |

DMFT = decayed/filled/missing teeth, SD = standard deviation.

**Table 3**

**Comparison of DMFT indices between a patient with digestive organ cancer and result of National Survey (2011) in 6th and 7th decades.**

| | Patient group | Control group (National Survey 2011) | |
|---|---|---|---|
| Number of subjects | 235 | 1619 | |
| DMFT | | | |
| Mean value (SD) | 18.93 (6.99) | 20.13 (6.60) | $P<.01$* |
| 95% CI | 18.04–19.83 | 19.80–20.45 | |
| Median value | 20 | Not supplied | |
| Decayed teeth | | | |
| Mean value (SD) | 0.55 (1.54) | 0.98 (2.14) | $P<.01$* |
| 95% CI | 0.36–0.75 | 0.87–1.08 | |
| Median value | 0 | Not supplied | |
| Missing teeth | | | |
| Mean value (SD) | 10.06 (8.41) | 9.04 (8.45) | $P=.08$* |
| 95% CI | 8.98–11.13 | 8.62–9.47 | |
| Median value | 8 | Not supplied | |
| Filling teeth | | | |
| Mean value (SD) | 8.32 (5.71) | 10.10 (6.17) | $P<.01$* |
| 95% CI | 7.59–9.05 | 9.80–10.40 | |
| Median value | 8 | Not supplied | |

CI = confidence interval, DMFT = decayed/filled/missing teeth, SD = standard deviation.
* Student *t* test.

**Table 4**

**Comparison of proportion of those who had residual teeth less than 20 between the digestive cancer patients and the result of the Japanese national survey (2011).**

| | Patients group | Control group (National Survey 2011) | |
|---|---|---|---|
| Total | | | |
| No. of subjects | 235 | 1619 | <.01* |
| No. who had less than 20 teeth (%) | 113 (48.1%) | 605 (37.3%) | |
| 60–69 yr-old | | | |
| No. of subjects | 108 | 835 | |
| No. who had less than 20 teeth (%) | 39 (36.1%) | 215 (25.7%) | $P<.05$† |
| 70–79 yr-old | | | |
| No. of subjects | 127 | 784 | |
| No. who had less than 20 teeth (%) | 74 (58.3%) | 390 (49.7%) | NS† |

* Chi-square test.
† Stratified analysis (Benjamini and Hochberg procedure).

### 3.2. Assessment of periodontitis in cancer patients

The results obtained on DMFT indices revealed that digestive cancer patients had a higher prevalence of missing teeth, but were not accompanied by dental caries, and, thus, an assessment of periodontal disease was performed. The characteristics of patients and a sample in the Japanese National Survey of Dental Diseases in 2016 were shown in Table 8. Among 230 patients, 14 had no evaluable dentition and, thus, 216 were available for the evaluation of periodontitis (CPI). There were 91 (42.1%) women and 125 (57.9%) men with a mean age of $65.2 \pm 9.8$ years. Regarding the cancer site, 107 (49.5%) cases were the small/large bowel, 59 (27.3%) the stomach, 16 (7.4%) the pancreas, and 12 (5.6%) the gallbladder. A comparison between the groups showed that the patient group comprised more men than the control group (the chi-squared test, $P<.01$).

A comparison of the prevalence of periodontitis (deep periodontal pockets) between cancer patients and the Japanese National Survey in 2016 was shown in Table 9. The prevalence of periodontitis (CPI codes 3 and 4; periodontal pocket depth greater than 4 mm) was significantly higher in the patient group than in the national survey (81.0 vs 52.7%, the chi-squared test, $P<.01$). The prevalence of severe periodontitis (CPI code 4; periodontal pocket depth greater than 6 mm) was also higher in the patient group (44.0 vs 12.4%, the chi-squared test, $P<.01$). Since the findings of the national survey revealed that periodontitis was dominant in men and older patients, the prevalence of periodontitis was compared between each sex and in each age group. The prevalence of periodontitis was higher in cancer patients than in the national survey for both sexes and each age group, except those in the 4th decade of life. The results of the comparison of the prevalence of periodontitis among patients with different cancer sites were shown in Supplemental Table 3, http://links.lww.com/MD/C890. No significant differences were observed among cancer sites (the chi-squared test, $P=.08$). Furthermore, the prevalence of periodontitis at each cancer site was higher than that in the national survey (2016);

**Table 6**

**Comparison of proportion of denture wearers between the digestive cancer patients and the result of Japanese national survey (2011).**

| | Patients group | Control group (National Survey 2011) | |
|---|---|---|---|
| Total | | | |
| No. of subjects* | 181 | 1619 | <.01† |
| No. of denture wearer (%) | 63 (34.8%) | 857 (52.9%) | |
| 60–69 yr-old | | | |
| No. of subjects* | 82 | 835 | |
| No. of denture wearer (%) | 23 (28.0%) | 308 (36.9%) | NS‡ |
| 70–79 yr-old | | | |
| No. of subjects* | 99 | 784 | |
| No. of denture wearer (%) | 40 (40.4%) | 549 (70.0%) | $P<.01$‡ |

* Patients who had no data concerning denture use were deleted.
† Chi-square test.
‡ Stratified analysis (Benjamini and Hochberg procedure).

**Table 5**

**Comparison of the proportion of those who had residual teeth less than 20 among the patients with different digestive system cancers.**

| | Esophagus | Stomach | Small/large bowel | Gallbladder | Pancreas | Liver | Control group (National Survey 2011) |
|---|---|---|---|---|---|---|---|
| Number of subjects | 25 | 60 | 45 | 21 | 20 | 61 | 1619 |
| Mean age (SD) | 70.64 (3.70) | 69.33 (5.15) | 69.69 (4.92) | 70.48 (5.46) | 69.80 (5.45) | 70.34 (5.21) | 69.61 (5.49) |
| No. who had less than 20 teeth (%) | 13 (52.0%) | 25 (41.7%) | 22 (48.9%) | 12 (57.1%) | 10 (50.0%) | 29 (47.5%) | 605 (37.3%) |

SD = standard deviation.

**Table 7**

**Comparison of proportion of denture wearer among patients with different digestive system cancers.**

| | Esophagus | Stomach | Small/large bowel | Gallbladder | Pancreas | Liver | Control group (National Survey 2011) |
|---|---|---|---|---|---|---|---|
| Number of subjects* | 16 | 49 | 35 | 17 | 15 | 47 | 1619 |
| Mean age (SD) | 71.31 (4.11) | 69.14 (5.22) | 69.97 (5.08) | 70.24 (5.67) | 70.07 (5.44) | 70.70 (5.29) | 69.61 (5.49) |
| No. of denture wearer (%) | 5 (31.3%) | 18 (36.7%) | 9 (25.7%) | 7 (41.2%) | 4 (26.7%) | 20 (42.6%) | 857 (52.9%) |

SD = standard deviation.

* Patients who lack a datum of denture wear were deleted.

however, patients with gallbladder cancer had a slightly lower prevalence of periodontitis.

## 4. Discussion

Oral diseases, such as dental decay and periodontitis, affect most adults in the global population[19] and are among one of the most costly diseases to treat for many health systems.[19,20] Chronic diseases have been associated with poorer oral health and greater unmet dental needs, including untreated dental diseases, self-reported poor oral health, and tooth loss.[21] Furthermore, oral diseases are associated with inflammation[22] and malnutrition.[23,24] However, the relationship between oral diseases and digestive system cancers remains unclear. In the present study, risk factors for dental caries were not available in the patient and epidemiological study groups. Although many cancer patients are male, gender differences in the incidence of dental caries were not previously reported in the national survey (2011).[17] Regarding age, since the prevalence of dental caries increases with advancing age, we focused on and compared patients in the 6th and 7th decade of life, which are the most susceptible ages for gastrointestinal cancer. This is the first study to examine the relationship between oral diseases and digestive system cancers using DMFT indices in Japanese patients.

Previous studies investigated the relationships between oral diseases, esophageal cancer,[4,5,7–9] and gastric cancer.[2,3,6,9,10] Tooth loss is generally regarded as a common consequence of chronic bacterial infections, such as periodontitis.[25] Furthermore, it may serve as a surrogate for chronic infections and inflammation, which may be important in the pathogenesis of cancer.[26] Periodontitis was reported to increase the probability of having oral leukoplakia, a premalignant lesion, in a dose-dependent manner (odds ratio [OR] = 5.3; 95% confidence interval [CI]: 1.2–22.7, for the highest severity of periodontitis).[27] The severity of periodontitis was also markedly associated with both precancerous lesions (OR = 1.55; 95% CI: 1.06–2.27) and oral cancer (OR = 4.57; 95% CI: 2.25–9.30).[28] Periodontal disease has been reported to influence carcinogenesis through the increased generation of carcinogens, specifically nitrosamines.[8]

**Table 8**

**Gender and age distribution of cancer patients and a sample of the Japanese National Survey of Dental Diseases in 2016.**

| (Man:Woman) Total | Patients group 216 (125:91) | Control (National Survey 2016) 2834 (1236:1598) |
|---|---|---|
| Age group | | |
| 40–49 | 5 (2:3) | 456 (174:282) |
| 50–59 | 31 (12:19) | 473 (181:292) |
| 60–69 | 57 (34:23) | 850 (381:469) |
| 70–79 | 92 (59:33) | 697 (338:359) |
| 80 =< | 31 (18:13) | 358 (162:196) |

Periodontal disease and poor oral hygiene are known to elevate oral bacteria levels, and markedly higher nitrosamine levels have been detected in the oral cavity due to the presence of nitrate-reducing bacteria.[8,29] Additionally, tooth loss reduces masticatory ability and may lead to the consumption of a less healthy diet, and reduced masticatory ability may also result in the deglutition of larger pieces of food, leading to mechanical injuries to the mucosal membrane in the oral cavity or esophagus.[8] *Helicobacter pylori* (*H pylori*) is the main pathogen causing gastritis and gastric cancer.[30,31] The ability of *H pylori* to coaggregate with Fusobacterium nucleatum and Fusobacterium periodonticum, which are early and late colonizers, respectively, of the mouth.[32] Therefore, dental plaque was reported to serve as a reservoir for this pathogen. According to Al Asqah et al,[33] among 101 patients, 65% of patients had dental plaque-positive for *H pylori* and more than 50% harbred the bacteria in their stomach. Periodontitis patients had a significantly higher percentage of *H pylori* in their dental plaque (79% vs 43%; $P < .05$) and the stomach (60% vs 33%; $P < .05$) than patients with no periodontitis. Additionally, the positive association was reported between *H pylori* infection and periodontal pathogens.[34] *H pylori* infection could influence the chronic periodontitis by the change of microecology and inflammation, and induce the severe progress of this disease.[34] The positive detection rate of *H pylori* was previously reported to be markedly higher in patients with moderate and severe periodontitis than in those with mild periodontitis.[35]

Only 1 previous study has shown that higher DMFT indices correlated with a greater risk of esophageal squamous cell carcinoma.[24] Therefore, the clinical significance of DMFT indices for digestive system cancers remains unclear. In gastrointestinal cancer patients, including those in the present study, DMFT indices were lower than in the national survey (2011). However, no significant differences were observed in primary sites of digestive system cancers. The D and F indices were both lower in gastrointestinal cancer patients, suggesting that these patients had fewer dental caries than the noncancer populations. In the present study, the M index was higher in digestive cancer patients. However, the proportion of patients with less than 20 residual teeth, suggesting the loss of molar teeth and associated decreased chewing ability, was higher in cancer patients than in the national survey. Furthermore, the proportion of denture wearers was significantly lower among cancer patients than in the national survey. Regarding the number of residual teeth, at least 12 front teeth and 8 premolars were reported to be necessary for satisfactory mastication;[36] 45% of individuals with 1 to 10 teeth exhibited some difficulty eating or were completely unable to eat apples, whereas only 12% of those with 21 or more teeth had the same limitation.[37] Individuals with less than 20 teeth were reported to have a higher chewing ability index score than those with more than 20 teeth.[38] Based on these findings, the Ministry of Health, Labour, and Welfare of Japan

**Table 9**

**Comparison of the prevalence of periodontitis (deep periodontal pocket) between the digestive cancer patients and the result of Japanese National Survey in 2016.**

| All subjects | Patient group | Control group (National Survey 2016) | *P*-value | Odds ratio (95% CI) |
|---|---|---|---|---|
| Pocket depth 4 mm =< | | | | |
| Total | 81.0% (175/216) | 52.7% (1494/2834) | <.01 | 3.65 (2.59–5.14) |
| 40–49 yr-old | 60.0% (3/5) | 44.7% (204/456) | NS | |
| 50–59 yr-old | 87.1% (27/31) | 50.7% (240/473) | <.01 | 6.55 (2.26–19.02) |
| 60–69 yr-old | 82.5% (47/57) | 59.4% (505/850) | <.01 | 3.21 (1.60–6.44) |
| 70–79 yr-old | 81.5% (75/92) | 54.4% (379/697) | <.01 | 3.70 (2.14–6.40) |
| 80 <=yr-old | 74.2% (23/31) | 46.4% (166/358) | <.01 | 3.33 (1.45–7.63) |
| Pocket depth 6 mm =< | | | | |
| Total | 44.0% (95/216) | 12.4% (352/2834) | <.01 | 5.54 (4.14–7.41) |
| 40–49 yr-old | 0.0% (0/5) | 4.8% (22/456) | NS | |
| 50–59 yr-old | 32.3% (10/31) | 9.9% (47/473) | <.01 | 4.32 (1.92–9.71) |
| 60–69 yr-old | 49.1% (28/57) | 16.6% (141/850) | <.01 | 4.85 (2.80–8.41) |
| 70–79 yr-old | 50.0% (46/92) | 14.1% (98/697) | <.01 | 6.11 (3.85–9.69) |
| 80 <= yr-old | 35.5% (11/31) | 12.3% (44/358) | <.01 | 3.93 (1.76–8.74) |
| **Man** | | | | |
| Pocket depth 4 mm =< | | | | |
| Total | 80.8% (101/125) | 55.8% (690/1236) | <.01 | 3.33 (2.10–5.27) |
| 40–49 yr-old | 50.0% (1/2) | 53.4% (93/174) | NS | |
| 50–59 yr-old | 91.7% (11/12) | 49.2% (89/181) | <.01 | 11.37 (1.44–89.91) |
| 60–69 yr-old | 85.3% (29/34) | 60.9% (232/381) | <.01 | 3.72 (1.41–9.84) |
| 70–79 yr-old | 78.0% (46/59) | 57.7% (195/338) | <.01 | 2.59 (1.35–4.98) |
| 80 <= yr-old | 77.8% 14/18 | 50.0% (81/162) | <.05 | 3.50 (1.10–11.09) |
| Pocket depth 6 mm =< | | | | |
| Total | 48.0% (60/125) | 15.7% (194/1236) | <.01 | 4.96 (3.38–7.27) |
| 40–49 yr-old | 0.0% (0/2) | 6.9% (12/174) | NS | |
| 50–59 yr-old | 33.3% (4/12) | 13.3% (24/181) | NS (*P*=.07) | |
| 60–69 yr-old | 58.8% (20/34) | 19.4% (74/381) | <.01 | 5.93 (2.86–12.28) |
| 70–79 yr-old | 49.2% (29/59) | 16.9% (57/338) | < .01 | 4.77 (2.66–8.55) |
| 80 <= yr-old | 38.9% (7/18) | 16.7% (27/162) | <.05 | 3.18 (1.13–8.95) |
| **Woman** | | | | |
| Pocket depth 4 mm =< | | | | |
| Total | 81.3% (74/91) | 50.3% (804/1598) | <.01 | 4.30 (2.51–7.35) |
| 40–49 yr-old | 66.7% (2/3) | 39.4% (111/282) | NS | |
| 50–59 yr-old | 84.2% (16/19) | 51.7% (151/292) | <.01 | 4.98 (1.42–17.46) |
| 60–69 yr-old | 78.3% (18/23) | 58.2% (273/469) | NS (*P*=.08) | |
| 70–79 yr-old | 87.9% (29/33) | 51.3% (184/359) | <.01 | 6.90 (2.83–20.02) |
| 80 <= yr-old | 69.2% (9/13) | 43.4% (85/196) | NS (*P*=.08) | |
| Pocket depth 6 mm =< | | | | |
| Total | 38.5% (35/91) | 9.9% (158/1598) | <.01 | 5.84 (3.71–9.20) |
| 40–49 yr-old | 0.0% (0/3) | 3.5% (10/282) | NS | |
| 50–59 yr-old | 31.6% (6/19) | 7.9% (23/292) | <.01 | 5.40 (1.88–15.53) |
| 60–69 yr-old | 34.8% (8/23) | 14.3% (67/469) | <.05 | 3.20 (1.31–7.84) |
| 70–79 yr-old | 51.5% (17/33) | 11.4% (41/359) | <.01 | 8.24 (3.87–17.55) |
| 80 <= yr-old | 30.8% (4/13) | 8.7% (17/196) | <.05 | 4.68 (1.30–16.81) |

CI = confidence interval.

initiated a campaign for the elderly to retain at least 20 teeth until the age of 80 years (known as the 8020 movement).[39] In a previous review of differences in the health conditions of 8020 achievers and 8020 nonachievers in 25 studies published mainly in Japan,[40] physical indices, such as height, weight, body mass index, bone mineral density, balance ability, grip strength, and exercise function, were better in 8020 achievers than in 8020 nonachievers. A strong inverse relationship between the number of teeth and heart rate was also detected.[40] Therefore, our results suggest the importance of more than 20 residual teeth, similar to previous findings.[36–40] Additionally, prosthetic treatments may effectively prevent digestive system cancers. Unlike periodontal disease, dental caries has not been directly linked to carcinogenesis and HNC rates.[41] Individuals who had been using dental care in the past 12 months were 62% less likely to be diagnosed with oral cancer among a population-based sample, after the adjustment for confounding variables.[42] Poor oral health and lack of access to dental care were reported to be independent risk factors for upper-aerodigestive tract cancer.[43] Therefore, the DMFT index might be affected by socioeconomic factors as confounders. In the present study, the relationship between the DMFT index and *H pylori* infection in digestive cancer patients was not investigated. Therefore, further studies are warranted.

Since the rate of dental caries was low and the number of missing teeth was high in the present study, an additional investigation on periodontal disease was conducted in an attempt to identify the reason for the small number of residual teeth. The results obtained revealed a higher prevalence of periodontal diseases in cancer patients than in the Japanese National Survey (2016). Since the findings of the national survey revealed that periodontitis was dominant in men and the elderly, the prevalence of periodontitis was compared between each sex and age group. The prevalence of periodontitis was higher in cancer patients than in the national survey for both sexes and age groups, except in the 4th decade of life. Since this was a retrospective study, we were unable to identify other risk factors. However, smoking, DM, and hypertension, which are associated with periodontal diseases in patients for whom DMFT indices were measured, were examined and compared with the national survey (Supplemental Table 4, http://links.lww.com/MD/C890)[44] at the same time. Although the prevalence of smoking was low, those of DM and hypertension were high. These results suggest that these are common risk factors for digestive system cancers and periodontal disease, similar to a previous study.[45]

The strength of the present study is that it examined the relationship between dental diseases and digestive system cancers using the DMFT index and the investigated subtypes of digestive system cancers. Although previous studies used self-reported data and did not measure specific indices of either caries or periodontal diseases, caries and periodontal diseases were both objectively measured in a consistent manner for all participants in the present study. The limitation of the present study was the difficulties associated with clarifying the relationships between other common risk factors, digestive system cancers, and periodontitis due to its retrospective nature. Additionally, although the digestive system, including esophagus, stomach, small/large bowel, gallbladder, pancreas, and liver, had wide diversity in such as histological type and treatment strategies, subclass analysis was not performed in each type of digestive system cancers in this study. Furthermore, the use of DMFT indices to measure the prevalence of disease among the elderly is limited due to progressively decreases in accuracy with advancing age.[46,47] Additionally, these indices were reported to difficult to provide accurate date about lesion in the early stages.[48] According to a scope review by EISalhy et al, there were variations among studies in the utilization of the dental caries assessment.[49] And the categorical characteristics of the International Caries Detection and Assessment System, which was a clinical examination system to detect carious lesion at different stages of development[49,50] A comparison study revealed that it was important for the choice of the best indices for epidemiological survey to consider the purpose of research and the target population.[51] Additionally, the weighted prevalence of dental infections/abscess during chemotherapy was 5.8%.[52] The conversion rate of previously diagnosed chronic disease to acute inter-therapy inflammation was reported 4%, and 10% of previous diagnosed severe chronic periodontitis was converted to acute periodontitis.[53] Therefore, the use of antineoplastic agents might affect on the M indices. Further studies on the relationship between oral diseases and digestive system cancers are needed using a large number of patients and a multicenter retrospective analysis.

In conclusion, the relationship between oral diseases and digestive system cancers was investigated herein. DMFT, D, and F indices were significantly lower in digestive system cancer patients than in the national survey, while the M index was slightly higher in digestive cancer patients. The higher proportions of individuals with less than 20 residual teeth and nondenture wearers among patients with digestive cancers were demonstrated in the present study. A higher prevalence of severe periodontitis in cancer patients was also revealed. The relationship between digestive organ diseases, such as cancer, and multitooth loss and/or a low denture-wearing rate was confirmed. These results suggest that periodontitis and associated multitooth loss play a role in digestive system cancers.

## Author contributions

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