Evaluation of Public Health Expenditure by Number of Teeth among Outpatients with Diabetes Mellitus

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Abstract

The relationship between public health expenditure and number of teeth was investigated in patients with diabetes mellitus using data obtained from the Japanese National Database of Health Insurance Claims and Specific Health Checkups. Data on medical, dental, and pharmacy claims generated between April 2015 and March 2016 were analyzed in patients with diabetes mellitus aged 50–74 years who used outpatient services during this period. Patients initiating medical and pharmacy claims related to diabetes mellitus were defined as having diabetes mellitus. Number of teeth was defined as number of teeth in conjunction with periodontitis due to the nature of the data source. Descriptive statistics were used to investigate the association between number of teeth and public health expenditure. Data on a total of 1,017,758 patients with diabetes mellitus were analyzed. Patients with the fewest teeth incurred higher medical expenses. The largest mean difference in medical expenditure was observed between patients with 5–9 teeth and those with over 28 teeth. The results of this study suggest that public health expenditure on patients with diabetes mellitus differs based on number of teeth.

Key words: Diabetes mellitus — Health expenditure — National database

Introduction

Patients with diabetes mellitus are at a higher risk of tooth loss than those without. Yoo et al.¹⁰ reported that the mean annual tooth loss was significantly higher among...
patients with diabetes mellitus (0.94) than among those without (0.709).

The rapid aging of society in Japan has been accompanied by an increase in public health expenditure\(^1\), indicating the need for optimization of public finances in this respect. To achieve this goal, the Ministry of Health, Labour, and Welfare created the National Database of Health Insurance Claims and Specific Health Checkups of Japan (NDB), which was tasked with storing health insurance-related medical information\(^2\).

In 2016, public health expenditure in Japan on patients with diabetes mellitus was over 1 trillion yen, with outpatients accounting for 75\% of this outlay. Increases in both income disparity and the proportion of the elderly in the population may eventually make it difficult for Japan to sustain universal health coverage\(^8\). Understanding such disparity in medical expenditure should allow policymakers to devise an overall strategy aimed at reducing it.

Tsuneishi \textit{et al.}\(^9\) reported that individuals with 20 or more teeth incurred less public health expenditure than those with 19 teeth or fewer. To our knowledge, however, no studies to date have used a large health-related database to investigate how public medical expenditure varies by number of teeth in patients with diabetes mellitus. Therefore, the purpose of the present study was to use the NDB to elucidate current public health expenditure by number of teeth in outpatients with diabetes mellitus.

**Materials and Methods**

1. **Data source**

Data on medical, dental, and pharmacy claims were obtained from the NDB on individuals aged 50–74 years who used outpatient services between April 2015 and March 2016. This age group was selected because the number of patients with diabetes mellitus is reported to be higher around the age of 50 years\(^8\). The selection criteria for patients whose data were analyzed are shown in Fig. 1.

Data linkage was performed using ID1, which is a hash value generated from the insurer’s ID\(^6\). To obtain information related to the medical and dental variables used in this study, data on patients who visited both medical and dental institutions were analyzed. The protocol of this study was approved by the Ethics Committee of Tokyo Dental College (approval number, 805).

2. **Definition of patients with diabetes mellitus**

Patients who filed insurance claims for outpatient services related to diabetes mellitus were identified based on the International Classification of Diseases, Tenth Revision (ICD-10) codes. However, some reports have suggested that the accuracy of identifying patients with diabetes mellitus may be higher when pharmacy claims are also considered\(^4\). Therefore, pharmacy claims for 475 medications were combined with outpatient service claims to improve the accuracy of patient identification. The ICD-10 and bill codes used

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Fig. 1 Selection criteria for patients included in study
to identify patients in this study are shown elsewhere\(^9\). Thus, this study defined patients with diabetes mellitus as those who filed claims for both outpatient and pharmacy services related to diabetes mellitus.

3. Definition of medical expenditure

Medical expenditure was defined as the sum of medical and pharmacy expenditure stored in the NDB, in which the sums involved are recorded in Japanese yen. Claims processed through the Diagnosis Procedure Combination were excluded. Therefore, only data on medical outpatient claims were included.

4. Definition of number of teeth

The NDB does not contain information regarding number of teeth due to the nature of the insurance system. Therefore, the number of teeth in patients with periodontitis (billing code: 5234009) was defined in accordance with the method used by Tsuneishi et al\(^9\). No edentulous patients were included. Patients were classified into the following 7 groups based on number of teeth: 1–4, 5–9, 10–14, 15–19, 20–24, 25–27, or 28 or more teeth.

5. Data analysis

Descriptive statistics were used to analyze the relationship between number of teeth and other variables obtained from the NDB. Public health expenditure by age, sex, and number of teeth is presented as mean and median values, as well as for the 25th and 75th percentiles. Data were analyzed using the statistical software package SPSS, version 25.0 (SPSS Japan, Inc.; Tokyo, Japan).

### Results

Table 1 shows the characteristics of the 1,017,758 patients (male: 627,838; female: 389,920). Patients aged 65–69 years accounted for 311,547 patients (30.6%). Most patients had 20 or more teeth (709,225 patients;
69.7%), while 3.2% of patients had 1–4 teeth (32,575 patients; 3.2%).

Figure 2 shows public health expenditure stratified by age, sex, and number of teeth. Patients with 5–9 teeth incurred the highest average public health expenditure among those aged 50–54 (males: 529,395 yen, females: 596,500 yen) or 55–59 (males: 505,480 yen, females: 560,394 yen). Conversely, patients with 28 or more teeth incurred relatively low average public health expenditure (50–54-year-old males, 391,121 yen, and females, 436,054 yen; 55–59-year-old males, 408,006 yen, and females, 415,430 yen). However, among patients aged 60–64, 65–69, or 70–74 years, the more teeth they had, the fewer the medical expenses they incurred; the only exception was women aged 70–74 years. Similar trends were observed for the medians and 75th percentiles, although the difference in the medians for public health expenditure in relation to number of
teeth was smaller than that of the means. For the 25th percentiles, public health expenditure in relation to number of teeth was similar across all groups.

**Discussion**

A number of earlier studies have reported the relationship between number of teeth and the likelihood of a person developing diabetes mellitus. Shin\(^6\) reported that a low number of teeth was associated with a high prevalence of chronic kidney disease in 2,519 patients. This complication can arise in patients with severe diabetes mellitus. Moreover, it is well-known that there is an association between periodontal disease and diabetes mellitus\(^3\). Therefore, it is reasonable to assume that patients with severe diabetes mellitus incurring high medical expenditure might lose more teeth due to severe periodontal disease. To our knowledge, this is the first study to report the actual situation regarding number of teeth and public health expenditure in patients with diabetes mellitus, particularly at a population level; however, it should be noted that patients with diabetes might have several related complications. Therefore, public health expenditure associated with other diseases might be a confounding variable.

This study had several limitations. Data linkage was performed by ID1; however, it has been reported that ID1 tends to overestimate the number of patients with diabetes mellitus\(^9\). Therefore, the number of patients with diabetes mellitus may have been overestimated. Additionally, due to the nature of ID1, the number of teeth lost might have been underestimated if it was changed during the observation period.

The number of patients with diabetes mellitus in the present study was lower than that reported in a previous study using NDB\(^4\). This difference may be explained by our only considering individuals who received treatment at both medical and dental institutions as patients with diabetes mellitus here. Therefore, the present findings are only applicable to Japanese outpatients with diabetes mellitus who visited medical and dental institutions under universal health coverage.

The NDB does not include medical treatment covered by public funds (\(i.e.,\) public assistance recipients) or not covered by public insurance. Therefore, public health expenditure might have also been underestimated in this study.

Regarding the measure for number of teeth, no edentulous individuals were included in the present study. Moreover, Tsuneishi *et al.* reported that when using the NDB, there is a tendency to overestimate number of teeth among patients aged 70 years or older by 10% or more\(^9\). However, the number of teeth was categorized in this study, suggesting that the observed trend between number of teeth and medical expenditure would not change.

In conclusion, the present results demonstrated that public health expenditure differed depending on number of teeth. This suggests that it is important for policymakers to keep in mind that patients with diabetes mellitus and a lower number of teeth may incur higher medical expenditure. Allocating resources to such patients might be effective in reducing such financial outlay.

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