



## Original article

## Association between dental caries and out-of-hospital cardiac arrests of cardiac origin in Japan



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## ABSTRACT

**Background:** Oral infection contributes to atherosclerosis and coronary heart disease. We hypothesized that dental caries may be associated with out-of-hospital cardiac arrests (OHCA) of cardiac origin, but not non-cardiac origin.

**Methods and results:** We compared the age-adjusted incidence of OHCA (785,591 cases of OHCA: 55.4% of cardiac origin and 44.6% of non-cardiac origin) to the age-adjusted prevalence of dental caries between 2005 and 2011 in the 47 prefectures of Japan. In both the total population and males over 65 years, the number of cases of dental caries was significantly associated with the number of OHCA of total and cardiac origin from 2005 to 2011, but not those of non-cardiac origin. In the total population, the age-adjusted prevalence of dental caries was not significantly associated with the age-adjusted incidence of OHCA (total OHCA:  $r$  correlation coefficient = 0.22,  $p = 0.14$ ; OHCA of cardiac origin:  $r = 0.25$ ,  $p = 0.09$ ; OHCA of non-cardiac origin:  $r = -0.002$ ,  $p = 0.99$ ). Among male patients over 65 years, the age-adjusted prevalence of dental caries was significantly associated with OHCA of total and cardiac origin, but not non-cardiac origin (total OHCA:  $r = 0.47$ ,  $p < 0.001$ ; OHCA of cardiac origin:  $r = 0.37$ ,  $p = 0.01$ ; OHCA of non-cardiac origin:  $r = 0.28$ ,  $p = 0.054$ ).

**Conclusions:** While oral hygiene is important in all age groups, it may be particularly associated with OHCA of cardiac origin in males over 65 years.

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## Introduction

Oral infection may contribute to coronary heart disease [1]. Oral infection and especially periodontal disease is associated with carotid artery intima-media thickness [2–4], stroke [5], coronary

heart disease [6–9], atherosclerotic vascular disease [10], and other cardiovascular disease [11–17]. Periodontal disease is also associated with cardiovascular death [18–21]. It has been reported that cardiovascular disease mortality was significantly higher among dentate patients with periodontal disease [relative risk (RR) 1.97, confidence interval (CI) 1.01–3.85] than among those without periodontal disease [20]. Ajwani et al. [18] reported that periodontitis more than doubled the risk of cardiovascular disease-related mortality among patients over 75 years old [hazard ratio (HR) 2.28, CI 1.03–5.05]. In addition, Saremi et al. [21] reported that severe periodontal disease had 3.2-fold risk (95% CI

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1.1–9.3) of cardiorenal mortality (ischemic heart disease and diabetic nephropathy combined) compared with a reference group after adjusting for risk factors, whereas it was not indicated that periodontal interventions prevent the atherosclerotic vascular disease or modify its outcomes [10]. Dental caries, as well as periodontitis, has also been reported to be associated with cardiovascular events [22–25], but the association in Japan has not been studied to date.

The estimated number of patients with dental caries was obtained from the Patient Survey published by the Ministry of Health, Labor and Welfare of Japan [26]. Cardiac events include various types such as coronary heart disease, arrhythmia, or syncope [27]. In January 2005, the Fire and Disaster Management Agency of Japan launched a prospective, nationwide, population-based, cohort study in subjects who had had an out-of-hospital cardiac arrest (OHCA) to evaluate the effect of the nationwide dissemination of public-access automated external defibrillators on the rate of survival among patients who had an OHCA [28–30], and we have access to this database. Therefore, as a working hypothesis, we assumed that dental caries would be associated with OHCA of cardiac origin.

An ecological study is an epidemiologic analysis in which the units of analysis are populations or groups of people rather than individuals. Such studies are useful for generating a hypothesis, and for comparing occupations, social classes, and generations. With the use of two different large databases, we performed an ecological study to investigate the association between dental caries and OHCA of cardiac origin according to the age distribution and sex.

## Methods

### Subjects

Patients who suffered from OHCA of cardiac or non-cardiac origin ( $n = 435,064$  and  $350,527$ , respectively) and who were enrolled in the All-Japan Utstein Registry of the Fire and Disaster Management Agency between 2005 and 2011 were included in this analysis. The estimated number of patients with dental caries was obtained from the Patient Survey published by the Ministry of Health, Labor and Welfare of Japan [26]. The populations in the 47 prefectures of Japan were obtained from the Annual Report on Current Population Estimates (2005–2011) published by the Ministry of Internal Affairs and Communications of Japan [31]. The study protocol for analyses was approved by the Ethics Committee of Fukuoka University (FU-#00000403), Japan.

### Age-adjusted incidence of OHCA

Using the Utstein Registry, we calculated the crude incidence of OHCA by determining the raw number of cases of OHCA by prefecture and then dividing these numbers by the population of the prefecture from 2005 to 2011. The Japanese Model Population in 1985 was used as a standard population, and age-standardization was performed by a direct method.

### Age-adjusted prevalence of dental caries

The estimated number of patients with dental caries was obtained from the Patient Survey published by the Ministry of Health, Labor and Welfare of Japan. This survey is performed once every three years in patients of medical care institutions across Japan who are selected by random stratified sampling. The estimated number of patients who received medical treatment in hospitals and general clinics on the dates surveyed was used. The data were not recorded within 99 patients in the age group of

this survey. We divided the estimated number of patients by the population of the prefecture for each year and expressed the results as the average prevalence of dental caries in 2005, 2008, and 2011. In the 2011 survey, the number of patients was not estimated in Fukushima prefecture or in part of Miyagi prefecture because of the Great East Japan Earthquake, and we excluded these two prefectures from the 2011 survey. The method for age-standardization was as described above.

### Statistical analysis

The statistical analysis was performed using SAS software, version 9.4 (SAS Institute, Cary, NC, USA) at Fukuoka University. We used a *t*-test for continuous variables and chi-squared tests for categorical variables. The Pearson product-moment correlation coefficient was used to evaluate associations between groups. The values are expressed as the mean  $\pm$  standard deviation (SD). Statistical significance was defined as a *p*-value of less than 0.05.

## Results

### Patient characteristics in the All-Japan Utstein Registry

There were 797,422 cases of OHCA in the All-Japan Utstein registry between 2005 and 2011, including 11,831 cases that did not receive resuscitation. Table 1 shows the patient characteristics in the All-Japan Utstein Registry between 2005 and 2011, excluding 11,831 in the no-resuscitation group: 785,591 cases of OHCA; 435,064 (55.4%) of cardiac origin; and 350,527 (44.6%) of non-cardiac origin. Non-cardiac origin included cerebrovascular disease, respiratory disease, malignant tumor, and exogenous disease (4.8%, 6.1%, 3.5%, and 18.9%, respectively). Patients with OHCA of cardiac origin were significantly older, and had a lower incidence of males and a higher incidence of 1-month survival, cerebral performance category 1 or 2, and overall performance category 1 or 2. The initial rhythms in OHCA of cardiac origin were significantly more likely to be ventricular fibrillation and pulseless ventricular tachycardia, and less likely to be pulseless electrical activity and asystole.

### Time trends for the number of patients with OHCA and dental caries in the 47 prefectures of Japan between 2005 and 2011

Yearly changes in the number of patients with OHCA and dental caries in Japan between 2005 and 2011 are shown in Fig. 1. The number of patients with OHCA of total, cardiac origin, and

**Table 1**  
Patient characteristics.

	Total ( $n = 785,591$ )	Cardiac origin ( $n = 435,064$ )	Non-cardiac origin ( $n = 350,527$ )
Age, years	72 $\pm$ 18	75 $\pm$ 16*	69 $\pm$ 21
Male, $n$ (%)	458,105 (58.3)	251,554 (57.8)*	206,551 (58.9)
ROSC, $n$ (%)	52,955 (6.7)	29,214 (6.7)	23,741 (6.8)
1-month survival, $n$ (%)	37,912 (4.8)	23,553 (5.4)*	14,359 (4.1)
CPC1 or 2, $n$ (%)	17,410 (2.2)	13,230 (3.0)*	4180 (1.2)
OPC1 or 2, $n$ (%)	17,223 (2.2)	13,109 (3.0)*	4114 (1.2)
<b>Initial rhythm</b>			
VF	55,192 (7.0)	47,606 (10.9)*	7586 (2.2)
pulseless VT	1862 (0.2)	1219 (0.3)*	643 (0.2)
PEA	166,976 (21.3)	87,158 (20.0)*	79,818 (22.8)
Asystole	528,193 (67.2)	282,336 (64.9)*	245,857 (70.1)

ROSC, return of spontaneous circulation; CPC, cerebral performance category; OPC, overall performance category; VF, ventricular fibrillation; VT, ventricular tachycardia; PEA, pulseless electrical activity.

\*  $p < 0.05$  vs. Non-cardiac origin.

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