Risk Factors of Mortality from Foreign Bodies in the Respiratory Tract: The Japan Collaborative Cohort Study

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Abstract:
Objective This study assessed the risk factors of mortality from foreign bodies in the respiratory tract using the Japan Collaborative Cohort Study for the Evaluation of Cancer Risk data.
Methods Data of 110,585 participants 40-79 years old living in 45 areas in Japan were collected between 1988 and 2009. Mortality from foreign bodies in the respiratory tract was assessed in a multivariable-adjusted analysis using a Cox proportional hazard regression model.
Results Among all participants, 202 deaths occurred from foreign bodies in the respiratory tract. In the multivariable-adjusted model, older age [50-59 (hazard ratio, 4.93; 95% confidence interval, 1.91-12.74), 60-69 (hazard ratio, 14.96, 6.01-37.25) and 70-79 (hazard ratio, 53.81; 95% confidence interval, 21.44-135.02) years old compared to 40-49 years old], male sex (hazard ratio, 2.34; 95% confidence interval, 1.54-3.54), a history of apoplexy (hazard ratio, 7.04; 95% confidence interval, 4.24-11.67) and the absence of a spouse (hazard ratio, 1.56; 95% confidence interval, 1.05-2.32) were associated with an increased risk of mortality from foreign bodies in the respiratory tract.
Conclusions Older age, male sex, medical history of apoplexy and the absence of a spouse were potential risk factors of mortality from foreign bodies in the respiratory tract. Especially in elderly men, social connections, such as cohabitation or relationships, may be important for ensuring the early detection of asphyxia and preventing death due to foreign bodies in the respiratory tract.

Key words: aged, asphyxia, airway obstruction, cohort studies, risk factors

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Introduction

The proportion of older adults is increasing worldwide, and deaths from foreign bodies in the respiratory tract are also increasing in many developed countries (1-4). Japan is the world’s most aged society, and airway problems as emergency medical issues among the elderly are increasing (1, 5, 6). Since 2006, choking due to airway foreign bodies has been the leading cause of unintentional accidental death in Japan (4). Among 1,381,093 deaths, 14,145 (1.0%; 10,149 men, 3,996 women) were reported to be due to foreign bodies in the respiratory tract. The incidence rates among people in their 40s, 50s, 60s and 70s were 0.61, 1.44, 3.45 and 13.34 per 100,000 population, respectively, in 2019 in Japan (7).

Older age has been reported to be a risk factor of airway problems in adults (8). Previous reports have also shown that an age-related decrease in the swallowing function, the use of sedative medications and stroke-related dysphagia, dementia and Parkinson’s disease are risk factors for choking and aspiration (9-12). In prehospital emergency patients, the presence of witnesses and a rapid response are related to the prognosis of cardiopulmonary arrest due to food choking (13, 14). Seasonal and regional validations of food choking deaths in Japan have also been reported (2, 14).

Foreign body airway obstruction (FBAO) occurs most often in children 1-3 years old and people over 60 years old (5, 15). Causes of FBAO include food or toys in children but are mostly food in the elderly (11). The most com-
mon causes of FBAO are meat, bread and rice cake in Japan (14, 16). In Japan, it has been reported that about 10% of FBAO is caused by the consumption of rice cakes, and about 25% of rice-cake FBAO cases occur during the first 3 days of the new year since it is popular in Japan to eat warm and soft rice cakes at that time (14). FBAO is sometimes fatal and can lead to cardiac arrest due to systemic hypoxia within minutes if not responded to quickly and appropriately. Cardiac arrest due to FBAO has been reported to have a poor neurological prognosis because of the prolonged hypoxia of the brain (14, 17). The rate of a favorable neurological outcome is less than 3% in out-of-hospital cardiac arrest patients following FBAO (13, 14). The importance of the early removal of a foreign body from the airway to prevent cardiac arrest has been reported (17). Therefore, it is important to identify the risk factors, prevent airway problems and prepare for airway emergencies, especially in the recently aging society. However, there are few reports on mortality from foreign bodies in the respiratory tract, and the risk factors are not well understood.

In this study, we examined the risk factors for death from foreign bodies in the respiratory tract using data from the Japan Collaborative Cohort Study for the Evaluation of Cancer Risk (JACC), a nationwide community-based cohort study.

Materials and Methods

Study population

This study was conducted using data from the JACC study, a prospective nationwide cohort study that was started in 1988, and the participants were followed until the end of 2009. In the JACC study, the data of 110,585 participants (46,395 men and 64,190 women) 40-79 years old living in 45 areas in Japan were collected using self-administered questionnaires about their lifestyles and medical histories. The JACC study was designed to evaluate the relationship between lifestyle and mortality from all causes, including cardiovascular diseases and major cancers, and to provide prevention strategies for chronic diseases. The details of this study have been previously described (18).

The procedures followed in this study were in accordance with the Declaration of Helsinki, and the study protocol was approved by the Ethics Committee of Hokkaido University School of Medicine, Japan.

Baseline assessments and risk factors

Participants’ demographic and lifestyle information was collected from self-administered questionnaires at the baseline of the JACC study. We classified age into four categories (40-49, 50-59, 60-69, 70-79 years old). Medical histories (present or absent) of apoplexy (APo), myocardial infarction (MI), hypertension (HT) and diabetes mellitus (DM); presence of a spouse (yes or no); education duration (<16, 16-19, ≥19 years); smoking history [yes (including ex-smokers) or no]; body mass index (BMI) according to the self-reported weight and height (<18.5, 18.5-23.4, 23.5-24.9, ≥25 kg/m²); and drinking status, calculated from the daily alcohol consumption and weekly frequencies [non-drinker (including ex-drinkers) and current drinkers of ethanol at <23, 23-25.9, 46-68.9, ≥69 g per day], were evaluated as possible risk factors based on the responses to the baseline questionnaire.

Follow-up

The mortality data of the participants in this study were obtained from the official death certificates provided by the Ministry of Health, Labor, and Welfare in Japan. The causes of death were determined by physicians, and the coding of the causes of death by the government was based on the 9th (used until 1994) and 10th Revisions (used from 1995) of the International Statistical Classification of Diseases and Related Health Problems (ICD-9 and ICD-10, respectively).

In this study, death from an FBAO was defined based on the following causes of death and codes: “Foreign body in the respiratory tract” (T17), which included “asphyxia due to foreign body” and “choking on food or phlegm” in ICD-10; and “Foreign body in the pharynx and larynx” (933), and “Foreign body in the trachea, bronchus, and lung” (934) in ICD-9. The follow-up of the causes of death in JACC study was continued until the end of 2009 in 35 communities, and 4, 4 and 2 communities had been followed-up as of 1999, 2003 and 2008, respectively.

Statistical analyses

The person-years of follow-up among participants were calculated as the period from the date of the baseline data collection to the date of either death, moving out of the area, or end of follow-up. Age-specific death rates due to foreign bodies in the respiratory tract were calculated by the participants’ attained age in the JACC study. Hazard ratios (HRs) and 95% confidence intervals (CIs) for death from foreign bodies in the respiratory tract were estimated in univariable, sex- and age-adjusted (Model 1) and multivariable (Model 2) Cox proportional hazards regression models. Multivariable models were adjusted for age, sex, medical history (APo, MI, HT or DM), presence of a spouse, education duration, smoking history, BMI and drinking status. Tests for trends in HRs were performed according to continuous values for education duration, BMI and drinking status. A stratified analysis was also conducted by age categories to predict the effects of covariates, such as medical history, presence of a spouse, education and drinking status. In all analyses, two-tailed p-values <0.05 were statistically significant. All of the analyses were conducted using the SAS software program, version 9.4 (SAS Institute, Cary, USA).

Results

During the 1,781,318 person-years of follow-up of the 110,585 participants, there were 202 deaths from foreign
Table 1. Baseline Characteristics of All the JACC Study Participants Included in This Study and Those That Died from Foreign Bodies in the Respiratory Tract.

| Characteristic                | All Case of foreign bodies |
|------------------------------|----------------------------|
| n (%)                        | 110,585                    |
| Age, n (%)                   |                            |
| <50                          | 27,233 (24.6%)             |
| 50-59                        | 33,879 (30.6%)             |
| 60-69                        | 33,622 (30.4%)             |
| ≥70                          | 15,851 (14.3%)             |
| Female, n (%)                | 64,190 (58.0%)             |
| Medical history, n (%)       |                            |
| APO No                       | 93,978 (85.0%)             |
| Yes                          | 1,496 (1.4%)               |
| Missing                      | 15,111 (13.7%)             |
| MI No                        | 92,889 (84.0%)             |
| Yes                          | 2,994 (2.7%)               |
| Missing                      | 14,702 (13.3%)             |
| HT No                        | 76,248 (68.9%)             |
| Yes                          | 22,531 (20.4%)             |
| Missing                      | 11,806 (10.7%)             |
| DM No                        | 90,798 (82.1%)             |
| Yes                          | 5,283 (4.8%)               |
| Missing                      | 14,504 (13.1%)             |
| Presence of spouse, n (%)    |                            |
| No                           | 12,252 (11.1%)             |
| Yes                          | 82,707 (74.8%)             |
| Missing                      | 15,626 (14.1%)             |
| Education year, n (%)        |                            |
| <16                          | 31,684 (28.7%)             |
| <19                          | 39,005 (35.3%)             |
| ≥19                          | 10,590 (9.6%)              |
| Missing                      | 29,306 (26.5%)             |
| Smoking history, n (%)       |                            |
| No                           | 60,484 (54.7%)             |
| Yes                          | 39,141 (35.4%)             |
| Missing                      | 10,960 (9.9%)              |
| Body mass index, n (%)       |                            |
| <18.5                        | 6,288 (5.7%)               |
| 18.5-23.4                    | 58,188 (52.6%)             |
| 23.5-24.9                    | 17,611 (15.9%)             |
| ≥25                          | 21,894 (19.8%)             |
| Missing                      | 6,604 (6.0%)               |
| Drinking status, n (%)       |                            |
| Non drinker                  | 55,026 (49.8%)             |
| Current drinker (ethanol g/day) |                        |
| <23 g/day                    | 12,574 (11.4%)             |
| 23-45.9 g/day                | 9,553 (8.6%)               |
| 46-68.9 g/day                | 7,597 (6.9%)               |
| ≥69 g/day                    | 3,524 (3.2%)               |
| Missing                      | 22,311 (20.2%)             |

APO: apoplexy, MI: myocardial infarction, HT: hypertension, DM: diabetes mellitus

In the present study, an older age, male sex, medical his-
Age-specific death rates due to a foreign body in the respiratory tract by attained age in the JACC study. Death rates of men (triangle), death rates of women (circle). JACC: Japan Collaborative Cohort Study for the Evaluation of Cancer Risk.

The absence of a spouse was associated with the risk of death from foreign bodies in the respiratory tract. The presence of a spouse may markedly influence the living conditions at the time of occurrence of a foreign body in the respiratory tract. With a foreign body in the respiratory tract, a patient goes into cardiac arrest within minutes if there is no appropriate resuscitation by witnesses, and the prognosis of the patient is poor because of systemic hypoxia, especially in the brain (4, 13, 14, 16). Therefore, preventive measures, such as swallowing training, oral care and meal assistance, are important for elderly individuals with an increased risk of foreign bodies in the respiratory tract. The time to remove foreign bodies from the airway affects the survival rate and neurological prognosis (12, 17, 25). Social relationships, such as cohabitation or other relationships, and meal-
The present study found that men had a higher risk of death from foreign bodies in the respiratory tract than women. This result is consistent with the findings of previous reports (3, 11, 26). It is possible that different lifestyles

time assistance are important for elderly individuals with multiple risk factors, as this ensures a quicker response, which can help prevent deaths from foreign bodies in the respiratory tract.

|                        | Case of foreign bodies | Person-year | \(^{a}\)Model 1 HR 95% CI | \(^{b}\)Model 2 HR 95% CI |
|------------------------|------------------------|-------------|---------------------------|---------------------------|
| **Age**                |                        |             |                           |                           |
| <50 years old          | 5 494,409              | 1.00        | 1.00                      |                           |
| 50-59 years old        | 30 589,104             | 5.34        | 2.26-15.68                | 4.93                      | 1.91-12.74                |
| 60-69 years old        | 77 513,783             | 17.33       | 7.01-42.86                | 14.96                     | 6.01-37.25                |
| ≥70 years old          | 90 184,023             | 69.70       | 28.22-172.15              | 53.31                     | 21.44-135.02              |
| **Sex**                |                        |             |                           |                           |
| Male                   | 121 727,710            | 2.48        | 1.87-3.28                 | 2.34                      | 1.54-3.54                 |
| Female                 | 81 1,053,609           | 1.00        |                           | 1.00                      |                           |
| **Medical history**    |                        |             |                           |                           |
| APO                    |                        |             |                           |                           |
| No                     | 147 1,545,656          | 1.00        | 1.00                      |                           |
| Yes                    | 20 17,151              | 6.21        | 3.86-9.99                 | 7.04                      | 4.24-11.67                |
| MI                     |                        |             |                           |                           |
| No                     | 163 1,530,339          | 1.00        | 1.00                      |                           |
| Yes                    | 2 36,702               | 0.30        | 0.07-1.19                 | 0.23                      | 0.06-0.99                 |
| HT                     |                        |             |                           |                           |
| No                     | 115 1,275,447          | 1.00        | 1.00                      |                           |
| Yes                    | 60 332,186             | 1.30        | 0.95-1.79                 | 1.16                      | 0.83-1.64                 |
| DM                     |                        |             |                           |                           |
| No                     | 154 1,498,298          | 1.00        | 1.00                      |                           |
| Yes                    | 15 71,125              | 1.39        | 0.82-2.36                 | 1.23                      | 0.68-2.22                 |
| **Presence of spouse** |                        |             |                           |                           |
| No                     | 36 178,835             | 1.59        | 1.07-2.37                 | 1.56                      | 1.05-2.32                 |
| Yes                    | 130 1,364,816          | 1.00        | 1.00                      |                           |
| **Smoking**            |                        |             |                           |                           |
| No                     | 84 1,005,828           | 1.00        | 1.00                      |                           |
| Yes                    | 93 607,871             | 1.06        | 0.72-1.56                 | 1.02                      | 0.69-1.51                 |
| Education year         |                        |             |                           |                           |
| <16 years              | 79 481,927             | 1.53        | 1.07-2.21                 | 1.54                      | 1.07-2.21                 |
| <19 years              | 47 631,505             | 1.00        | 1.00                      |                           |
| ≥19 years              | 12 167,927             | 0.74        | 0.39-1.40                 | 0.75                      | 0.40-1.42                 |
| **Body mass index**    |                        |             |                           |                           |
| <18.5 kg/m²            | 15 88,246              | 1.13        | 0.65-1.95                 | 1.12                      | 0.65-1.94                 |
| 18.5-23.4 kg/m²        | 103 943,207            | 1.00        | 1.00                      |                           |
| 23.5-24.9 kg/m²        | 30 290,627             | 1.07        | 0.71-1.61                 | 1.03                      | 0.69-1.55                 |
| ≥25 kg/m²              | 34 362,691             | 1.03        | 0.70-1.53                 | 0.99                      | 0.67-1.47                 |
| **Drinking status**    |                        |             |                           |                           |
| Non drinker            | 80 880,613             | 1.00        | 1.00                      |                           |
| Current drinker (ethanol g/day) |            |             |                           |                           |
| <23 g/day              | 17 204,849             | 0.91        | 0.53-1.57                 | 0.98                      | 0.57-1.69                 |
| 23-45.9 g/day          | 28 150,883             | 1.44        | 0.90-2.32                 | 1.51                      | 0.93-2.44                 |
| 46-68.9 g/day          | 16 122,732             | 1.21        | 0.68-2.16                 | 1.23                      | 0.69-2.22                 |
| ≥69 g/day              | 9 55,213               | 1.96        | 0.95-4.05                 | 2.11                      | 1.01-4.39                 |
| \(^{a}\)Model 1: Adjusted for age, sex | \(^{b}\)Model 2: Adjusted for age, sex, APO, MI, HT, DM, presence of spouse, education year, smoking, body mass index, drinking status
APO: apoplexy, MI: myocardial infarction, HT: hypertension, DM: diabetes mellitus, HR: hazard ratio, CI: confidence interval
between men and women may affect the risk of death from foreign bodies in the respiratory tract. Further investigations are needed to determine the cause of these sex differences in airway problems.

Differences in countries and food cultures affect the causes of FBAO. In Japan, there is a culture of eating hot and soft rice cakes during the new year, and indeed, about 25% of rice-cake-related FBAO incidents occur within the first 3 days of the new year (14). Regional variations in incidents of FBAO in Japan due to the consumption of rice cakes are also reported (5). In Italy, pizza is reported to be a food with the highest risk of FBAO for adults (27). Tube feeding has also been reported as a potential risk factor of FBAO, the installation of which has recently been increasing among patients in Japan (28).

Several limitations associated with the present study warrant mention. First, we evaluated the mortality of participants using ICD-10 (T17: “Foreign body in respiratory tract”) and ICD-9 codes (933: “Foreign body in the pharynx and larynx” and 934: “Foreign body in the trachea, bronchus, and lung”). Data concerning external causes of death were not collected in this study, so we were unable to examine the relationship with the following ICD-10 (W79: “Inhalation and ingestion of food causing obstruction of the respiratory tract”) and ICD-9 codes (799: “Asphyxia”). Second, because this study was based on information from a baseline questionnaire survey, we were unable to adjust for detailed information about changes in lifestyle, living environment and the physical condition of the participants. Third, although previous studies reported that a rapid and appropriate response was related to the prognosis of asphyxia (12, 13), we were unable to obtain detailed information concerning the emergency care delivered by the witness. Further detailed investigations are needed concerning the risk factors for death from foreign bodies in the respiratory tract.

In conclusion, older age, male sex, a medical history of APO and the absence of a spouse were potential risk factors for death from foreign bodies in the respiratory tract. It is important to ensure that elderly men with a history of APO who do not have a spouse maintain social connections, such as cohabitants or relatives, to aid in the early detection of asphyxia. The prognosis of cardiac arrest from foreign bodies in the respiratory tract is poor, so we should be familiar with the risk factors of airway problems and pay attention to elderly individuals with multiple risk factors in order to prevent avoidable deaths from foreign bodies in the respiratory tract.

The authors state that they have no Conflict of Interest (COI).

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**Table 3.** Hazard Ratios and 95% Confidence Intervals for Death from Foreign Bodies in the Respiratory Tract in Multivariable Cox Hazard Regression Analysis Stratified by Age Categories.

| Age Group | Case of foreign bodies | Person-year | HR | 95% CI | Case of foreign bodies | Person-year | HR | 95% CI | Case of foreign bodies | Person-year | HR | 95% CI |
|-----------|------------------------|-------------|----|--------|------------------------|-------------|----|--------|------------------------|-------------|----|--------|
| 50-59     | 18 238,933 1.92 0.64-5.77 | 50 204,629 2.70 1.34-5.45 | 51 69,946 2.23 1.23-4.05 |
| 60-69     | 12 350,171 1.00          | 27 209,154 1.00          | 39 114,077 1.00          |
| 70-79     | 22 518,018 1.00          | 52 423,098 1.00          | 68 141,113 1.00          |
| Presence of spouse | No 3 4,045 14.34 3.90-52.80 | Yes 10 7,249 13.55 6.14-27.02 |
| Education year | No 15 430,121 1.00 | Yes 11 103,789 2.51 1.08-5.82 |
| Drinking status | No 25 513,645 1.00 | Yes 0 8,700 NA |

All results were adjusted for age, sex, APO, MI, HT, DM, presence of spouse, education year, smoking, body mass index and drinking status.

APO: apoplexy, MI: myocardial infarction, HT: hypertension, DM: diabetes mellitus.
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