



Article

Differences in stroke and ischemic heart disease mortality by occupation and industry among Japanese working-aged men



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ABSTRACT

Occupation- and industry-based risks for stroke and ischemic heart disease may vary among Japanese working-aged men. We examined the differences in mortality rates between stroke and ischemic heart disease by occupation and industry among employed Japanese men aged 25–59 years. In 2010, we obtained occupation- and industry-specific vital statistics data from the Japanese Ministry of Health, Labour, and Welfare dataset. We analyzed data for Japanese men who were aged 25–59 years in 2010, grouped in 5-year age intervals. We estimated the mortality rates of stroke and ischemic heart disease in each age group for occupation and industry categories as defined in the national census. We did not have detailed individual-level variables. We used the number of employees in 2010 as the denominator and the number of events as the numerator, assuming a Poisson distribution. We conducted separate regression models to estimate the incident relative risk for stroke and ischemic heart disease for each category compared with the reference categories “sales” (occupation) and “wholesale and retail” (industry). When compared with the reference groups, we found that occupations and industries with a relatively higher risk of stroke and ischemic heart disease were: service, administrative and managerial, agriculture and fisheries, construction and mining, electricity and gas, transport, and professional and engineering. This suggests there are occupation- and industry-based mortality risk differences of stroke and ischemic heart disease for Japanese working-aged men. These differences in risk might be explained to factors associated with specific occupations or industries, such as lifestyles or work styles, which should be explored in further research. The mortality risk differences of stroke and ischemic heart disease shown in the present study may reflect an excessive risk of Karoshi (death from overwork).

1. Introduction

Long working hours may be a risk factor for stroke and ischemic heart disease (Kivimäki et al., 2015). The Japanese Ministry of Health, Labour and Welfare designated Karoshi (a Japanese word meaning death due to overwork) as part of the national compensation scheme in 2001 (Ministry of Health, Labour and Welfare, 2015b). This included stroke (e.g., cerebral hemorrhage, cerebral infarction, subarachnoid hemorrhage and hypertensive encephalopathy) and ischemic heart disease (e.g., angina pectoris, sudden cardiac arrest, and dissecting aneurysm of the aorta). To determine compensation, the compensation agency scrutinized the background of each death if the onset of disease was triggered by work; for example, high levels of stress before the onset of disease(s), and short- and long-term overload assessed by the amount of overtime. Both lethal and recovered cases were covered by

this compensation (Iwasaki, Takahashi, & Nakata, 2006).

To date, about 400 cases of stroke (22% fatal events) and 250 cases of ischemic heart disease (65% fatal events) have been approved by the compensation agency each year (Ministry of Health, Labour and Welfare, 2015a). A review of the available statistics indicates that some occupations and industries have more cases approved. For example, transportation (24%) had the highest number of all approved Karoshi cases due to stroke and ischemic heart disease.

Occupation and industry is an important risk factor about stroke and ischemic heart disease (Honjo, 2014; Kunst et al., 1999; Luckhaupt & Calvert, 2014; Robinson et al., 2015). Occupational cardiovascular risk factors in farm and office environments include shift work, extreme heat, cold, noise, carbon disulfide, nitroglycerin, carbon monoxide, and stress (Robinson et al., 2015). About working hours in Japan, workers in construction and transportation industry

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worked longer than those in other industries (Statistics Bureau, 2015). Though the differences of mortality ratio between occupations and industries were confirmed in suicide and mental disorder (Eguchi, Wada, Higuchi, Yoneoka, & Smith, 2015; Wada, Eguchi, Prieto-Merino, & Smith, 2015) in Japan, the study in order to confirm the differences of mortality ratio due to ischemic heart disease and stroke were limited.

We hypothesized that the populations at risk for stroke and ischemic heart disease may be determined by occupation and industry. Occupation- or industry-based risk differences have previously been found for suicide among Japanese working-aged males (Wada et al., 2015). We compared rates of stroke and ischemic heart disease across different occupations and industries to identify which occupations and industries had high or low rates of disease, and which might pose risk or protective factors associated with cardiovascular disease. We also looked for clues to work-related etiological factors for cardiovascular disease. Details about the risk differences of stroke and ischemic heart disease may help to identify target populations needing interventions to prevent premature death and Karoshi. These occupation- and industry-based risk differences for stroke and ischemic heart disease may reflect differences in lifestyles and work styles associated with the risks for these diseases. The Japanese Ministry of Health, Labour, and Welfare collects occupation- and industry-specific vital statistics at 5-year intervals, during the same year as the National Census. This dataset may delineate the risk of death by occupation and industry. This is the first study to examine occupation- and industry-based differences in the mortality rates for stroke and ischemic heart disease among employed Japanese men aged 25–59 years. We excluded unemployed men who had already been identified as a high-risk group for stroke and ischemic heart disease to focus on the differences between occupations and industries (Nakao, 2010).

2. Methods

2.1. Statistical analysis

We examined data for Japanese men who were aged 25–59 years in 2010, grouped into 5-year age intervals. We estimated the mortality rates of stroke and ischemic heart disease for each age group in the occupation and industry categories defined in the national census. We used the number of employees in 2010 as the denominator and the number of events as the numerator, assuming a Poisson distribution. We conducted separate regression models to estimate the incident relative risk (IRR) for stroke and ischemic heart disease in each occupational category compared with the reference category “sales group.” We then conducted separate regression models to estimate the IRR for stroke and ischemic heart disease in each industry compared with the reference industry “wholesale and retail.” We examined whether the occupation or industry differed by age by fitting interaction terms with age classified in 5-year age interval groups (7 groups); detailed information about the statistical analysis have been published elsewhere (Wada et al., 2015). To confirm the interaction effects of age, two additional analyses were conducted. We examined the interactions with age using three age groups (25–39, 40–49, 50–59). We also examined the interactions with age by including only industries/occupations with more than 100 deaths from stroke and ischemic heart disease. We drew scatter plot of the relative risks for IHD versus those for stroke of the occupations and industries. Data were analyzed using STATA version 14 (StataCorp LP; College Station, TX, USA).

2.2. Data sources

We obtained the dataset for occupation- and industry-specific vital statistics from the Japanese Ministry of Health, Labour, and Welfare in 2010. We calculated occupation- and industry-specific death rates based on the 2010 national population census at 1 October 2010 (also

implemented at 5-year intervals on 1 October).

2.3. Measurements

Death certificate data includes the underlying cause of death. This is completed by physicians based on the sequence of events leading to the death and coded according to the International Classification of Diseases, 10th Revision (World Health Organization, 1992). Ischemic heart disease includes ICD-10 codes I200–I259 and I460–I469, and stroke includes codes I600–I639, I674, I710–I719.

In the years in which occupation- and industry-specific vital statistics were collected, family members of deceased people were required to report the occupation and industry of the deceased person. The families were given occupation and industry lists, and corresponding descriptions and definitions, and asked to select one occupational and one industry category. The occupation list included 11 occupations: administrative and managerial; professional; clerical; sales; services; security; agriculture; manufacturing; transport; construction and mining; and carrying, cleaning, and packaging. The industry list comprised 19 industries: agriculture; fisheries; mining; construction; manufacturing; electricity and gas; information; transport; wholesale and retail; finance; real estate and rental; research and professional services; accommodation and dining services (e.g., hotels, and eating and eateries); amusement services; education; medical and welfare; compound services (e.g., postal services and cooperative associations); other service industries; and government.

These categories are based on Japanese Standard Classification of Occupations (Ministry of Internal Affairs and Communications, 2009). Detailed lists of occupations and industries have been published elsewhere (Wada et al., 2015).

2.4. Ethics

We requested access to the dataset from the Ministry of Health, Labour and Welfare, Japan, based on the Statistics Act of Japan. We obtained de-identified data for research purposes, and formal ethics approval and informed consent were not required.

3. Results

Table 1 presents the distribution of stroke and ischemic heart disease mortality cases by occupations and industries. Stroke accounted for 4875 deaths among Japanese men aged 25–59 years. We excluded 1633 men who were unemployed at the time of death, 944 without an occupation category, and 1045 without an industry category. The total number of stroke cases analyzed was 2298 by occupation and 2197 by industry. Ischemic heart disease accounted for 6735 deaths among Japanese men aged 25–59 years. We excluded 2648 men who were unemployed at the time of death, 1320 without an occupation category, and 1490 without an industry category. The total number of ischemic heart disease cases analyzed was 2767 by occupation and 2597 by industry. The highest mortality for stroke was for the occupation “service” and industry “mining” and for ischemic heart disease was for the occupation “administrative and managerial” and industry “mining.” The largest number of death cases for stroke and ischemic heart disease for occupation was “professional and engineering” and for industry was “manufacturing.”

Table 2 and Fig. 1 shows the relative mortality risk for stroke and ischemic heart disease by occupation among males aged 25–59 years. Compared with “sales” the “service,” “administrative and managerial,” “agriculture, construction and mining,” “transport and machine operation,” and “professional and engineering” categories had higher relative mortality risks for stroke and ischemic heart disease. No interaction was found between age and occupation.

The age-adjusted Incident Relative Risks by industry for stroke and ischemic heart disease are shown in Table 3 and Fig. 2. “mining,”

Table 1

Mortality rate due to stroke and ischemic heart disease, by occupation and industry among Japanese males aged 25–59 years in 2010.

| | Number of people in total | | Number of deaths due to stroke | | Mortality rate due to stroke per 100,000 | Number of deaths due to ischemic heart disease | | Mortality rate due to ischemic heart disease per 100,000 |
|------------------------------------|---------------------------|--------|--------------------------------|--------|--|--|--------|--|
| | n | (%) | n | (%) | | n | (%) | |
| Occupation | (n=23,349,301) | (100) | 2298 | (100) | | 2767 | (100) | |
| Service | 1,354,438 | (5.8) | 329 | (14.3) | 24.3 | 373 | (13.5) | 27.5 |
| Administrative and managerial | 661,738 | (2.8) | 148 | (6.4) | 22.4 | 222 | (8.0) | 33.5 |
| Agriculture | 544,632 | (2.3) | 130 | (5.7) | 23.9 | 157 | (5.7) | 28.8 |
| Construction and mining | 1,955,771 | (8.4) | 259 | (11.3) | 13.2 | 257 | (9.3) | 13.1 |
| Transport and machine operation | 1,464,903 | (6.3) | 189 | (8.2) | 12.9 | 231 | (8.3) | 15.8 |
| Professional and engineering | 3,734,063 | (16.0) | 386 | (16.8) | 10.3 | 520 | (18.8) | 13.9 |
| Manufacturing process | 4,527,816 | (19.4) | 282 | (12.3) | 6.2 | 316 | (11.4) | 7.0 |
| Carrying, cleaning, packaging | 1,252,228 | (5.4) | 82 | (3.6) | 6.5 | 80 | (2.9) | 6.4 |
| Security | 725,493 | (3.1) | 48 | (2.1) | 6.6 | 65 | (2.3) | 9.0 |
| Clerk | 3,614,473 | (15.5) | 231 | (10.1) | 6.4 | 252 | (9.2) | 7.0 |
| Sales | 3,513,746 | (15.0) | 214 | (9.3) | 6.1 | 294 | (10.6) | 8.4 |
| Industry | (n=22,990,733) | (100) | 2197 | (100) | | 2597 | (100) | |
| Mining | 13,460 | (0.1) | 17 | (0.8) | 126.3 | 17 | (0.7) | 126.3 |
| Fisheries | 68,412 | (0.3) | 33 | (1.5) | 48.2 | 33 | (1.3) | 48.2 |
| Electricity and gas | 211,138 | (0.9) | 68 | (3.1) | 32.2 | 78 | (3.0) | 36.9 |
| Agriculture | 449,240 | (2.0) | 124 | (5.6) | 27.6 | 152 | (5.9) | 33.8 |
| Amusement services | 553,089 | (2.4) | 88 | (4.0) | 15.9 | 124 | (4.8) | 22.4 |
| Accommodations and dining services | 776,134 | (3.4) | 99 | (4.5) | 12.8 | 129 | (5.0) | 16.6 |
| Compound services | 183,818 | (0.8) | 25 | (1.1) | 13.6 | 25 | (1.0) | 13.6 |
| Construction | 2,746,977 | (11.9) | 342 | (15.6) | 12.5 | 371 | (14.2) | 13.5 |
| Transport | 1,951,734 | (8.5) | 234 | (10.7) | 12.0 | 279 | (10.6) | 14.3 |
| Other services | 1,346,970 | (5.9) | 141 | (6.4) | 10.5 | 177 | (6.8) | 13.1 |
| Information | 1,032,077 | (4.5) | 80 | (3.6) | 7.8 | 87 | (3.4) | 8.4 |
| Finance | 571,999 | (2.5) | 52 | (2.4) | 9.1 | 51 | (2.0) | 8.9 |
| Manufacturing | 5,158,183 | (22.4) | 391 | (17.8) | 7.6 | 448 | (17.2) | 8.7 |
| Medical and welfare | 1,050,457 | (4.6) | 71 | (3.2) | 6.8 | 85 | (3.3) | 8.1 |
| Research and professional services | 951,351 | (4.1) | 66 | (3.0) | 6.9 | 65 | (2.5) | 6.8 |
| Government | 1,252,730 | (5.4) | 89 | (4.1) | 7.1 | 114 | (4.4) | 9.1 |
| Real estate and rental | 376,875 | (1.6) | 22 | (1.0) | 5.8 | 28 | (1.1) | 7.4 |
| Wholesale and retail | 3,432,310 | (14.9) | 207 | (9.4) | 6.0 | 263 | (10.1) | 7.7 |
| Education | 863,779 | (3.8) | 48 | (2.2) | 5.6 | 71 | (2.7) | 8.2 |

Table 2

Relative stroke and ischemic heart disease mortality risk by occupation among males aged 25–59 years in 2010.

| Variable | Stroke | | Ischemic heart disease | |
|---------------------------------|---------------|-------------------------|------------------------|-------------------------|
| | Relative risk | 95% Confidence Interval | Relative risk | 95% Confidence Interval |
| Service | 4.56 | (3.30–6.29) | 3.72 | (2.81–4.92) |
| Administrative and managerial | 2.93 | (2.09–4.10) | 2.68 | (2.01–3.59) |
| Agriculture | 2.75 | (1.96–3.87) | 2.55 | (1.90–3.42) |
| Construction and mining | 1.94 | (1.36–2.78) | 1.40 | (1.01–1.94) |
| Transport and machine operation | 1.78 | (1.24–2.57) | 1.58 | (1.15–2.17) |
| Professional and engineering | 1.68 | (1.17–2.43) | 1.67 | (1.22–2.29) |
| Manufacturing process | 1.05 | (0.70–1.58) | 0.86 | (0.59–1.23) |
| Carrying, cleaning, packaging | 1.02 | (0.68–1.54) | 1.01 | (0.65–1.34) |
| Security | 0.99 | (0.66–1.50) | 0.96 | (0.68–1.37) |
| Clerk | 0.91 | (0.60–1.39) | 0.71 | (0.48–1.05) |
| Sales | ref | | ref | |

*Age adjusted, ref: reference

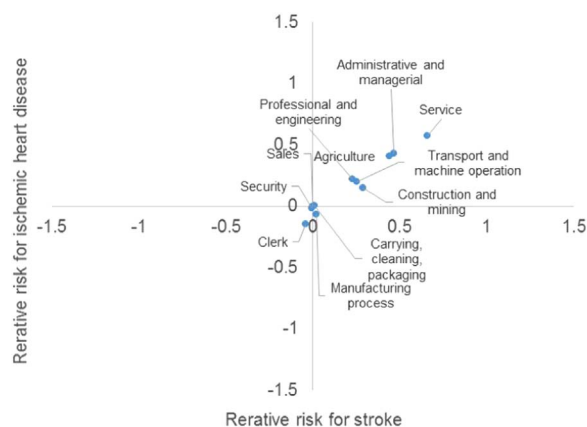


Fig. 1. Plot of the relative risks for ischemic heart disease vs. stroke by occupations. Relative risk for ischemic heart disease and stroke was log-transformed.

“fisheries,” “electricity and gas,” “agriculture,” “amusement services,” “accommodation and dining services,” “compound services,” “construction,” “transport,” “other services,” and “information” all had a high risk for stroke and ischemic heart disease. No interaction was found between age and industry.

4. Discussion

We determined the premature mortality risk for stroke and

Table 3
Relative stroke and ischemic heart disease mortality risk by industry among males aged 25–59 years in 2010.

| Variable | Stroke | | Ischemic heart disease | |
|------------------------------------|---------------|---------------------------|------------------------|---------------------------|
| | Relative risk | (95% Confidence Interval) | Relative risk | (95% Confidence Interval) |
| Mining | 15.1 | (11.1–20.5) | 17.9 | (13.6–23.4) |
| Fisheries | 6.63 | (4.82–9.11) | 5.28 | (3.96–7.04) |
| Electricity and gas | 4.90 | (3.54–6.79) | 4.30 | (3.21–5.76) |
| Agriculture | 3.30 | (2.35–4.63) | 3.28 | (2.43–4.44) |
| Amusement services | 2.98 | (2.11–4.19) | 3.31 | (2.45–4.47) |
| Accommodations and dining services | 2.23 | (1.56–3.19) | 2.26 | (1.65–3.10) |
| Compound services | 2.06 | (1.43–2.95) | 1.60 | (1.14–2.24) |
| Construction | 1.85 | (1.28–2.67) | 1.59 | (1.13–2.22) |
| Transport | 1.78 | (1.23–2.58) | 1.65 | (1.18–2.31) |
| Other services | 1.57 | (1.07–2.29) | 1.54 | (1.10–2.16) |
| Information | 1.54 | (1.05–2.26) | 1.45 | (1.03–2.04) |
| Finance | 1.30 | (0.88–1.93) | 1.04 | (0.72–1.50) |
| Manufacturing | 1.26 | (0.85–1.87) | 1.13 | (0.79–1.63) |
| Medical and welfare | 1.17 | (0.78–1.75) | 1.16 | (0.81–1.67) |
| Research and professional services | 1.09 | (0.72–1.65) | 0.85 | (0.57–1.25) |
| Government | 1.06 | (0.70–1.61) | 1.07 | (0.74–1.54) |
| Real estate and rental | 0.92 | (0.60–1.42) | 0.90 | (0.62–1.32) |
| Wholesale and retail | ref | | ref | |
| Education | 0.78 | (0.50–1.22) | 0.88 | (0.60–1.29) |

Age adjusted, ref: reference.

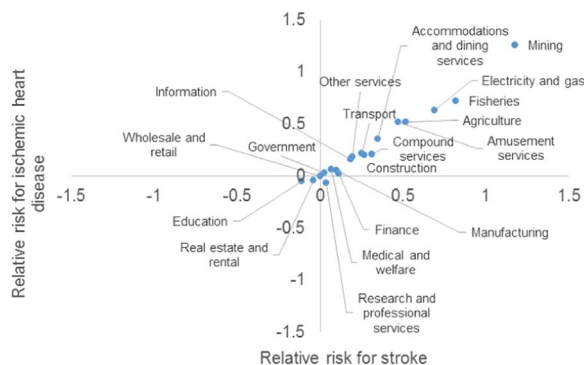


Fig. 2. Plot of the relative risks for ischemic heart disease vs. stroke by industries. Relative risk for ischemic heart disease and stroke was log-transformed.

ischemic heart disease by occupation and industry among Japanese men aged 25–59 years. We found that compared with sales (occupation) or wholesale and retail workers (industry), occupations and industries with a relatively higher risk of stroke and ischemic heart disease were as follows: “service” (amusement services, accommodation and dining services, compound services, information and other services); “administrative and managerial”; “agriculture and fisheries”; “construction and mining”; “electricity and gas”; “transport”; and “professional and engineering.”

The service occupations had the highest mortality risk for both stroke and ischemic heart disease among Japanese working-aged men. We identified specific service industries (amusement, accommodation, dining services, compound, information and other services) that had higher risks for both stroke and ischemic heart disease. Among employed adults in the United States, the service industry was found to have a higher risk of a history of coronary heart disease and stroke

(Luckhaupt & Calvert, 2014). One of the possible mechanisms by which service occupations had higher mortality risk of both stroke and ischemic heart disease is the adverse psychosocial loads and lack of healthy behaviors characteristics of these occupations. For example, a meta-analysis found that workers with high job stress and low job control, such as service workers, had a higher risk of stroke (Huang et al., 2015). A previous longitudinal study also showed that at baseline, Japanese middle-aged men in the service industry had a risk for serious mental illness, which may also be associated with stroke and ischemic heart disease (Eguchi et al., 2015). Workers in amusement, accommodation, and dining services are often required to work at night, with these industries having the highest number of night shift workers (28.6%) (Ministry of Health, Labour and Welfare, 2012). This tendency was also found among workers in the United States (Luckhaupt & Calvert, 2014).

A previous study found that the mortality for administrative workers, and professional and engineering workers (who are usually of a higher social class), increased from 2000 to 2005, a mortality increase worse than in other occupations that mostly comprise workers from lower social classes; this has been attributed to the economic depression in Japan (Wada et al., 2012). We found that the “administrative” and “professional and engineering” categories had a higher risk for stroke and ischemic heart disease mortality in 2010 compared with other lower social class occupations. This result may be explained by the characteristics of administrative and professional occupations in Japan. Companies downsized their organizations after the economic recession in the 1990s; consequently, the proportion of managers in the labor market decreased from 6.7% in 1995 to 3.2% in 2005. These changes in work environment could have increased the responsibilities and job demands of managers compared with manufacturing and clerical workers (Wada et al., 2012, 2016). The dataset used in the present study also indicated that the “administrative” category had the highest risk of suicide mortality in 2010 among working-aged men, possibly owing to stress from business difficulties and long working hours (Ministry of Health, Labour and Welfare, 2012). The same dataset indicated similar risk increment for suicide among these occupations (Wada et al., 2015).

Japanese men who were manual workers, including those in the primary sector that directly use natural resources (e.g., agriculture, forestry, fishing and mining, and construction), had a higher risk for stroke and ischemic heart disease. This tendency has also been found in studies in Europe and the United States (Kunst et al., 1999; Luckhaupt & Calvert, 2014; Robinson et al., 2015) and in Australia (De Looper & Magnus, 2005). This group also has a high risk of smoking-related diseases; the proportion of construction workers who are smokers (57%) is the highest among working-aged men in Japan (Ministry of Health, Labour and Welfare, 2010). Manufacturing workers are often classified as blue-collar workers, and are a high-risk group for these diseases (Torén et al., 2014). However, in this study, manufacturing did not have a risk level significantly different from the reference category (sales). This result is inconsistent with finding from a previous study, which indicated that manufacturing workers are a high-risk group for these diseases (Torén et al., 2014). This discrepancy may be explained by improvements in the work environment. Manufacturing in Japan has developed better practices (e.g., reduced working hours and measures to improve employees’ mental health) that may have improved health outcomes (Wada et al., 2012).

In Japan, transportation work tends to require long working hours (Statistics Bureau, 2015), which are associated with cardiovascular diseases (Kivimäki et al., 2015). The Survey on State of Employees’ Health showed that in 2013, transportation had the highest proportion of workers (19%) who worked more than 60 h per week (Ministry of Health, Labour and Welfare, 2012). Truck drivers are at increased risk for a number of chronic diseases and health problems, such as heart disease, diabetes mellitus, hypertension, and obesity (Apostolopoulos, Sönmez, Shattell & Belzer, 2010; Laden, Hart, Smith, Davis, &

Garshick, 2007). Many transportation workers not only work long hours, but are also likely to smoke and be overweight; these factors may contribute to poor health in these workers (Sieber et al., 2014). This may explain why the transportation industry also has the highest proportion of Karoshi (death due to overwork) compensation claims (Ministry of Health, Labour and Welfare, 2015b). It may be essential for workers in this type of occupation to improve their lifestyle habits to avoid premature death due to cardiovascular diseases.

The present study had some limitations. We do not have individual level data but aggregates by occupation (industry) and age category. There may be individual-level variables, such as smoking or other lifestyle factors, that could explain these results and for which we are unable to adjust. Second, for the vital statistics for death (numerator), the family of the deceased person selected the occupation and industry of the deceased. Therefore, possible misclassification of occupation and industry might have affected the outcome of the present study. For example, as managerial jobs occur in several different sectors, such as sales and services, relatives might have misclassified participants' occupations. Therefore, the association of occupation and industry with stroke and ischemic heart disease may be weak. Third, there may be differences in responses, including non-response, to the questions on occupation between the census and a death certificate. Also, while the information of occupation- and industry-specific number of death (numerator) was based on death certificates, the number of occupation- and industry-specific employed persons, denominator, was derived from the census conducted on 1 October 2010. These may have influenced the precision of estimates to a degree. Fourth, we could not get the information about socioeconomic status. Socioeconomic deprivation has shown a correlation with mortality (Vathesatogkit, Batty, & Woodward, 2014). The difference socioeconomic status among occupations and industries might influence the estimates. Finally, detailed information about employment status, such as regular or casual employment type, was not identified. Casual employment type is associated with poor lifestyle habits and subjective health (Inoue, Tsurugano, & Yano, 2011; Nakao et al., 2010). Occupations and industries in Japan vary in their rates of non-regular employment, which may weaken the association of occupation and industry with stroke and ischemic heart disease.

5. Conclusion

In the present study, we identified the risk differences of stroke and ischemic heart disease based on occupations and industries among Japanese working age men. These differences in risk might be explained to factors associated with specific occupations or industries, such as lifestyles or work styles, which should be explored in further research. The risk differences of stroke and ischemic heart disease shown in the present study may reflect an excessive risk of Karoshi (death from overwork).

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