Neighborhood Deprivation and Risk of Cancer Incidence, Mortality and Survival: Results from a Population-Based Cohort Study in Japan

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Abstract

Background: In many developed countries, socioeconomic status is associated with cancer incidence and survival. However, research in Japan is sparse. We examined the association between neighborhood deprivation based on the Japanese Deprivation Index and the risk of incidence, mortality and survival from total and major cancers in the Japan Public Health Center-based Prospective Study.

Methods: 86,112 participants were followed through the end of 2009. A total of 10,416 incident cases and 5,510 deaths from cancer were identified among 1,348,437 person-years of follow-up (mean follow-up: 15.7 years). The Japanese deprivation index was used to access neighborhood deprivation. Hazard ratios and 95% confidence intervals were calculated by Cox regression analysis.

Results: We found no associations between neighborhood deprivation index and the incidence of total and major cancers. In some cancer risks or deaths, however, we found positive or inverse associations with a higher deprivation index, such as a decreased risk of colorectal cancer incidence and an increased risk of liver cancer incidence and deaths in women.

Conclusion: Although some positive or inverse associations were detected for specific sites, the neighborhood deprivation index has no substantial overall association with the risk of incidence, mortality and survival from cancer in the Japanese population.

Introduction

In many developed countries, socioeconomic status (SES) is associated with cancer incidence and survival [1–6]. Although this association is not completely understood, some cancers are thought to be caused by lifestyle habits in the community, such as smoking, which tend to be concentrated among the poorer segments of a population [7]. Possible explanations for the association between SES and cancer survival include a delay in diagnosis and poor access to treatment in low SES groups [8]. Although Japan has an extensive welfare system and equal access to health care [9], one study showed associations between poor gastric cancer survival and job status, such as unemployment and manual labor [10].

Although socioeconomic position is usually expressed in terms of individual income, education, and/or occupation, areal deprivation, as a group factor, is also used to express relative poverty in area [11]. One Japanese study in a metropolitan area showed an inverse association between cervical and endometrial cancer survival and areal deprivation according to area unemployment rate [12]. However, no population-based study with a wider focus on the association between areal deprivation and cancer has yet appeared.
Here, we evaluated the association between the incidence, mortality and survival of all sites and major sites of cancer in a large population-based cohort study and the Japanese Deprivation Index (JDI), an index of neighborhood deprivation suitable for use in Japan. We wanted to test if areal deprivation increases the risk of incidence, mortality and survival of all cancers and major cancer sites in a non-metropolitan cohort setting.

Materials and Methods

Ethics Statement
The protocol of the Japan Public Health Center-based Prospective Study (JPHC Study) was approved by the Institutional Review Board of the National Cancer Center, Japan (approval number: 13-021). We informed the detail of the study to all study subjects orally and/or in writing at baseline survey. In our study we did not get written informed consent from all participants since our study was initiated in 1990, which was before ethical guideline for epidemiologic studies was enforced in 2002 in Japan. Instead, we informed the detail of the study to all study participants not only at baseline survey, but also through mails several times during follow-up. The protocol of the study including this was approved by the institutional review board annually since 2001, based on current ethical guideline.

Study Populations
Study participants were Japanese inhabitants enrolled in the JPHC Study Cohorts I and II, a large-scale population-based study. Details of the JPHC study have been provided elsewhere [13,14]. Briefly, the study was launched in January 1990 (Cohort I) and 1993 (Cohort II), and covered five and six public health center (PHC)-based areas, respectively.

In the baseline study, we identified 117,125 men and women aged 40–59 years for Cohort I and 40-69 years for Cohort II, with two areas excluded because information on cancer incidence and/ or deprivation index was not available. During the follow-up period, 229 participants were excluded because of erroneous identification (n = 170), non-Japanese nationality (n = 51), duplicate registration (n = 4) and unsuitable age (n = 4). 95,292 participants responded to the questionnaires (81.5% response rate). At this point, participants with a history of cancer at baseline and incidence, mortality, and survival of all sites of cancer and cancer at major sites, namely stomach (ICD-O-3: C16), colon (C18), rectum (C19, C20), liver (C22), pancreas (C25), lung (C34), breast (C50) and prostate (C61). STATA version 12.0 (Stata Corp, College Station, TX) [22] was used for all analyses.

Assessment of deprivation
Neighborhood deprivation was assessed using the JDI, a deprivation index developed by Nakaya [15,16]. The JDI is a composite indicator which consists of weighted sums of a number of census-based variables calculated using the same method as the Breadline Britain poverty measure [17] and European transnational ecological deprivation measure [18,19]. Deprivation-related variables were obtained from the 1995 population census.

Follow-up
We followed study participants from the baseline survey until December 31, 2009. Changes in residence status, including survival, were confirmed annually by the residential registry. Among study participants, 14,075 died, 6,911 moved out of the study area, 6 withdrew from the study, and 305 (0.3 percent) were lost to follow-up within the follow-up period. Due to a lack of precise cancer incidence data outside the study area, those who moved out of the study area were censored at the time they moved. For those who moved within the study area, we did not consider changing neighborhood deprivation status.

Confirmation of cancer mortality
Information on the cause of death for deceased participants was obtained from death certificates [provided by the Ministry of Health, Labour, and Welfare, with permission], which include cause of death as defined according to the International Classification of Diseases, Tenth Revision [20]. Resident registration and death registration are required by law in Japan, and the registries are believed to be complete. During the follow-up period, 5,510 cancer deaths were identified.

Confirmation of cancer incidence
The occurrence of cancer was identified by active patient notification from major local hospitals in the study area and from data linkage with population-based cancer registries, with permission from each of the local governments responsible for the cancer registries. When incidence data were unavailable, death certificate information was used as a supplementary information source. Cancer sites included in this study were coded according to the International Classification of Diseases for Oncology, Third Edition (ICD-O-3) [21]. In our cancer registry system, the proportion of cancer cases ascertained by death certificate only (DCO) was 5.6%. For the present analysis, the earliest date of diagnosis was used in cases with multiple primary cancers diagnosed at different times. We identified 10,416 newly diagnosed cancer cases during the follow-up period.

Statistical analysis
We prospectively counted the number of person-years of follow-up for each subject from the date of completion of the questionnaire until the date of diagnosis of cancer, date of death, movement out of the study area, or end of the study period (December 31, 2009), whichever occurred first. For cancer cases, person-years were further calculated for survival analysis from the date of cancer diagnosis until December 31, 2011.

A Cox proportional hazards regression model with the clustered sandwich estimator was applied to calculate the multivariate-adjusted hazard ratio (HR) and 95% confidence interval (CI) of associations between quartile of neighborhood deprivation index and incidence, mortality, and survival of all sites of cancer and cancer at major sites, namely stomach (ICD-O-3: C16), colon (C18), rectum (C19, C20), liver (C22), pancreas (C25), lung (C34), breast (C50) and prostate (C61). STATA version 12.0 (Stata Corp, College Station, TX) [22] was used for all analyses.

We used the multivariate model including age (continuous) (age at diagnosis for cancer survival) and study area (nine public health centers), population density (quartile), occupation (professional or office worker, sales clerk or other, farmer, or manual laborer and unemployed), smoking (never, past, current), alcohol drinking (none, ≤150 ml, 150–300 ml, 300–450 ml, ≥450 ml for men and none, ≤150 ml, >150 for women), body mass index (BMI) (≤18, ≥18, ≥20), and leisure time sport activity (none, once per 1–3 months, more than once a week). These variables, obtained from the questionnaire, are either known or suspected from earlier studies to be risk factors for outcome. For incidence and survival of prostate cancer, HRs were also estimated by clinical stage (i.e., localized or advanced). We also implemented additional sensitivity analyses which included education as a confounder (junior high school, high school and college or higher) to the multivariate model among Cohort I only (n = 38,340) due to a lack of education information among Cohort II.
The proportional hazards assumptions were tested using scaled Schoenfeld residuals and a graphical plot of the cumulative rate on a log scale, and no violation was found. We calculated $p$ values for the analysis of linear trends using the median values of each neighborhood deprivation index category in the regression model. All reported $p$ values are two-tailed.

**Results**

Tables 1 and 2 compares the characteristics of participants according to neighborhood deprivation index quartile. For men (Table 1), those with a higher neighborhood deprivation index were more likely to be older, a farmer or unemployed, a non-smoker, and more obese, and less likely to have undergone cancer screening. Similar trends were observed for women (Table 2). Women with a high neighborhood deprivation index tended to drink less alcohol, but showed no difference in drinking behavior pattern to those with a low index. No consistent trends in the proportion of population density or frequency of leisure time sports activity were observed across neighborhood deprivation categories. Those who were lost to follow-up (n = 305, 0.3% of the study participants) tended to be younger than those who were not lost, but had substantially similar baseline characteristics for other variables.

Tables 3 and 4 showed that neighborhood deprivation index was generally not associated with the risk of total cancer incidence, mortality or survival in either men or women, although we observed some significant inverse or positive associations in specific sites of cancer. In men (Table 3), an inverse association was observed in colorectal cancer, particularly rectal cancer, in which men in the highest deprivation index category had decreased risks of colorectal (HR, 0.73; 95%CI, 0.57–0.98, $p$ for trend 0.050) and rectal cancer (HR, 0.54; 95%CI, 0.36–0.82, $p$ for trend 0.007). We also observed a sporadic positive association in prostate cancer incidence and rectal cancer mortality, albeit that no significant linear trend of risk increase by increased deprivation index was observed. No remarkable association with neighborhood deprivation index was observed for cancer survival in men.

In women (Table 4), we observed a decreased risk of incidence and mortality in rectal cancer (incidence: HR for the highest quartile, 0.34; 95%CI, 0.22–0.92, $p$ for trend 0.010; mortality: HR for the highest quartile, 0.28; 95%CI, 0.10–0.76, $p$ for trend 0.029) and mortality in colorectal cancer (HR for the highest quartile, 0.49; 95%CI, 0.26–0.90, $p$ for trend 0.029). We also observed an increased risk of incidence and mortality in liver cancer, although no significant linear trend was observed. We found no association between neighborhood deprivation index and stomach, pancreas, lung or breast cancer. Further, no remarkable association was observed between neighborhood deprivation index and cancer survival in women.

We examined the association between neighborhood deprivation index and cancer incidence, death and survival among Cohort I after adding education as a confounder (junior high school, high school and college or higher) to the multivariate model. However, the results of these additional analyses did not substantially differ from our original analyses.

**Discussion**

In this study, we found that the neighborhood deprivation index had no substantial overall association with the risk of incidence, death due to, or survival from major cancer in Japanese men and women. However, we did find positive or inverse associations for some specific sites. Among these, the risk of colorectal cancer incidence was lower in men and women with a higher neighborhood deprivation index than in those in lower index categories. Further, the risk of liver cancer incidence and mortality was increased in women with higher neighborhood deprivation. There were no significant differences in cancer survival. Results of additional analysis using Cohort I only with adjustment for education were similar to those of the original analyses.

There are several possible explanations for these findings. First, concerning the lower risk of colorectal cancer incidence and mortality in those living in more deprived areas, a national colorectal cancer screening program for middle and older aged people in Japan started in 1992, the same time as the start point of this study [23]. Thus, the effect of a delay in screening program may not fully explain these inverse associations. Rather, they might be explained by differences in lifestyle between deprived areas and less deprived areas. One risk factor for colorectal cancer is the adoption of a westernized lifestyle [24], and participants in less deprived, more westernized areas are thus at greater risk of this cancer than those in deprived areas.

Second, the strong association of infection with hepatitis B virus (HBV) and hepatitis C virus (HCV) with social class [25] suggests that higher infection rates in deprived areas might lead to a high incidence and mortality of liver cancer. Interestingly, however, we found an association in women only, and not in men. The risk of liver cancer is increased in HBV- or HCV-infected patients with heavy alcohol intake [26], and we speculate that these strong underlying risk factors mask the effect of neighborhood deprivation index on liver cancer through HBV or HCV infection in men. In contrast, a large proportion of women in this cohort did not drink alcohol, and we were therefore able to detect this putative effect in women.

Third, there is no evidence to suggest the presence of gaps in cancer treatment by neighborhood deprivation in Japan. Access to cancer treatment after diagnosis is considered to be uniform for all people in Japan thanks to the universal health coverage system [9]. This may also be applied to cancer, where most patients, regardless of socioeconomic status, are transferred to large hospitals after diagnosis and are considered to receive almost equal quality of cancer treatment. This may explain why we found no significant differences in cancer survival by neighborhood deprivation index.

Strengths of our study are its prospective design and large sample size, which yielded good statistical power to detect the effects of neighborhood deprivation. The areas included in the present study were derived from nine different areas across Japan, both north and south, and included cities, towns and villages. This caused wide variation in the distribution of deprivation-related census variables, such as household structure and occupational distribution. Our analysis also covered a wide range of cancer outcomes, which allowed the simultaneous analysis of cancer incidence, mortality and survival.

There are several limitations to our study. First, we included only middle aged Japanese at the baseline in this study. Likewise, we did not include data from metropolitan areas due to an incidental lack of cancer incidence data or insufficient deprivation index data, and our findings might therefore not be applicable to populations in these areas. Urban/rural settings may have distinct environmental and lifestyle backgrounds, with differential effects on the association between neighborhood deprivation and outcomes. A previous study in Osaka, the second largest prefecture in Japan, found poor survival in cervical and endometrial cancer among deprived women. Osaka prefecture has the highest number of households receiving welfare assistance in Japan, and the poor survival might have been due to the greater variation in
neighborhood deprivation in Osaka than in the areas included in our study. Second, we did not consider changing the neighborhood deprivation status of those study participants who moved within the study area. In our population, however, we confirmed that only 2% of the study participants fell into this category, and the failure to consider movement within the study area might not have substantially influenced the results.

Third, we did not include individual educational level as a confounding factor in our statistical model, because information on this factor was obtained from Cohort I participants only (44.5% of total participants), which would significantly reduce statistical power. However, additional sensitivity analysis which included educational level as a confounding factor using Cohort I showed similar results. Among participants who did have educational information, nearly 50% graduated from junior high school only, consistent with the generation born around World War II, when a

Table 1. Baseline characteristics in men (n = 40,883).

| Deprivation Index Quartile | Lowest | Second | Third | Highest |
|----------------------------|--------|--------|-------|---------|
| Median                     | 478.8  | 530.8  | 591.3 | 698.3   |
| [Min-Max]                  | [165.8–504.2] | [504.7–555.8] | [556.5–624.4] | [627.6–983.3] |
| Number of participants     | 10,532 | 10,713 | 9,766 | 9,872   |
| Age (%)                    |        |        |       |         |
| ≤44                        | 25     | 25.2   | 23.9  | 23      |
| 45–49                      | 20.7   | 20.9   | 20.1  | 17.5    |
| 50–54                      | 19.2   | 19.9   | 20.5  | 19.2    |
| ≥55                        | 35.1   | 34     | 35.5  | 40.3    |
| Population density (%)     |        |        |       |         |
| Lowest                     | 11     | 21.5   | 31.5  | 34.8    |
| Second                     | 36.6   | 25.8   | 19.3  | 20.4    |
| Third                      | 18.2   | 28.6   | 39.8  | 13.8    |
| Highest                    | 34.2   | 24.1   | 9.4   | 31.1    |
| Occupation (%)             |        |        |       |         |
| Professionals and office workers | 34.7   | 29.1   | 24    | 19.1    |
| Sales clerk or others      | 14.9   | 16.8   | 16.9  | 15.6    |
| Farmers                    | 17.3   | 17.8   | 27.3  | 32.5    |
| Manual laborers            | 27.6   | 31.5   | 27.1  | 26.6    |
| Unemployed                 | 5.5    | 4.8    | 4.7   | 6.3     |
| Smoking (%)                |        |        |       |         |
| Never smoking              | 19.1   | 22.4   | 25.5  | 30.3    |
| Past smoking               | 24     | 22.9   | 21.4  | 23.8    |
| Current smoking            | 56.9   | 54.7   | 53.1  | 46      |
| Weekly alcohol consumption |        |        |       |         |
| None                       | 20.9   | 19.7   | 22.1  | 27      |
| ≤150 ml                    | 32     | 34.2   | 34.6  | 36.2    |
| 150–300 ml                 | 25.1   | 23.8   | 21.4  | 15.8    |
| 300–450 ml                 | 13.5   | 14.2   | 13.3  | 11.1    |
| ≥450 ml                    | 7.5    | 8.1    | 8.6   | 9.9     |
| BMI (%)                    |        |        |       |         |
| ≤18                        | 4.4    | 4.7    | 3.6   | 3.6     |
| ≥30                        | 1.5    | 1.8    | 2.2   | 3.2     |
| Sports (%)                 |        |        |       |         |
| None                       | 65.3   | 63.6   | 66.3  | 69.4    |
| Once per 1–3 months        | 16.8   | 17.5   | 15.3  | 11.5    |
| More than once a week      | 17.9   | 18.9   | 18.4  | 19.2    |
| History of cancer screening (%) | 17.2   | 18.7   | 20.5  | 22.3    |
| Yes                        | 82.8   | 81.3   | 79.5  | 77.7    |

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different education system was in place. Moreover, educational level in these participants was not associated with neighborhood deprivation index or cancer outcome.

Fourth, the neighborhood deprivation index used in the present study may have been affected by a methodological limitation: the JDI was initiated based on a commonly recognized areal deprivation index in England, but the presence of similar patterns in other contexts such as Japan is unclear. A previous study identified an association between poor gastric cancer survival and the job status of unemployed and manual labor [10]. Our study covered the same data source as this study, and our additional analyses using occupation as deprivation showed similar results. On this basis, the neighborhood deprivation index appears to be an unsuitable predictor of cancer survival in Japan.

**Conclusion**

The Japanese neighborhood deprivation index has no substantial association with total cancer incidence, deaths or survival in Japanese men and women. Although neighborhood deprivation index is used in many studies in European countries and shows positive associations with cancer outcome, it appears that...
Table 3. Deprivation index and cancer risk in men (n = 40,883).

| Deprivation Index Quartile | Number of participants | Number of cases | Number of deaths among cases | Incidence HR* (95%CI) | Death HR* (95%CI) | Survival HR* (95%CI) |
|----------------------------|------------------------|----------------|----------------------------|-----------------------|------------------|----------------------|
| All sites                  | 6,360                  | 3,013          | 3,678                      |                       |                  |                      |
| Lowest                     | 10,532                 | 1,693          | 827                        | 985                   | 1.00             | 1.00                 |
| Second                     | 10,713                 | 1,650          | 749                        | 919                   | 0.94 (0.87–1.01) | 1.00 (0.95–1.07)     |
| Third                      | 9,766                  | 1,453          | 679                        | 840                   | 0.96 (0.88–1.06) | 1.01 (0.95–1.09)     |
| Highest                    | 9,872                  | 1,564          | 758                        | 934                   | 0.90 (0.80–1.00) | 1.00 (0.92–1.09)     |
| p for trend                |                        |                |                            |                       | 0.086            | 0.083                |
| Stomach (C16)              | 1,383                  | 482            | 712                        |                       |                  |                      |
| Lowest                     | 10,532                 | 444            | 173                        | 244                   | 1.00             | 1.00                 |
| Second                     | 10,713                 | 393            | 125                        | 187                   | 0.95 (0.82–1.10) | 0.93 (0.81–1.08)     |
| Third                      | 9,766                  | 294            | 102                        | 149                   | 0.95 (0.79–1.15) | 0.95 (0.79–1.15)     |
| Highest                    | 9,872                  | 252            | 82                         | 132                   | 0.95 (0.76–1.19) | 0.91 (0.73–1.14)     |
| p for trend                |                        |                |                            |                       | 0.069            | 0.329                |
| Colorectum (C18-C20)       | 1,207                  | 307            | 474                        |                       |                  |                      |
| Lowest                     | 10,532                 | 320            | 89                         | 127                   | 1.00             | 1.00                 |
| Second                     | 10,713                 | 315            | 72                         | 121                   | 0.91 (0.75–1.09) | 0.93 (0.88–1.34)     |
| Third                      | 9,766                  | 287            | 62                         | 105                   | 0.93 (0.74–1.16) | 0.92 (0.83–1.36)     |
| Highest                    | 9,872                  | 285            | 84                         | 121                   | 0.75 (0.57–0.98) | 0.91 (0.73–1.14)     |
| p for trend                |                        |                |                            |                       | 0.050            | 0.592                |
| Colon (C18)                | 800                    | 172            | 278                        |                       |                  |                      |
| Lowest                     | 10,532                 | 203            | 40                         | 69                    | 1.00             | 1.00                 |
| Second                     | 10,713                 | 208            | 47                         | 75                    | 0.97 (0.78–1.21) | 1.07 (0.81–1.42)     |
| Third                      | 9,766                  | 186            | 30                         | 55                    | 1.04 (0.79–1.36) | 0.87 (0.61–1.24)     |
| Highest                    | 9,872                  | 203            | 55                         | 79                    | 0.87 (0.62–1.24) | 1.01 (0.68–1.51)     |
| p for trend                |                        |                |                            |                       | 0.067            | 0.966                |
| Rectum (C19-C20)           | 407                    | 135            | 196                        |                       |                  |                      |
| Lowest                     | 10,532                 | 117            | 49                         | 58                    | 1.00             | 1.00                 |
| Second                     | 10,713                 | 107            | 25                         | 46                    | 0.79 (0.60–1.04) | 1.11 (0.80–1.53)     |
| Third                      | 9,766                  | 101            | 32                         | 50                    | 0.75 (0.52–1.06) | 1.40 (1.04–1.88)     |
| Highest                    | 9,872                  | 82             | 29                         | 42                    | 0.54 (0.36–0.82) | 1.27 (0.81–1.98)     |
| p for trend                |                        |                |                            |                       | 0.007            | 0.185                |
| Liver (C22)                | 425                    | 366            | 378                        |                       |                  |                      |
| Lowest                     | 10,532                 | 104            | 94                         | 86                    | 1.00             | 1.00                 |
| Second                     | 10,713                 | 112            | 94                         | 99                    | 1.20 (0.92–1.57) | 1.06 (0.96–1.16)     |
| Third                      | 9,766                  | 89             | 78                         | 87                    | 1.16 (0.82–1.63) | 1.15 (1.03–1.28)     |

*HR: Hazard Ratio, CI: Confidence Interval

p for trend: p-values for trend across deprivation indices.
| Deprivation Index Quartile | Number of participants | Number of cases | Number of deaths | Number of deaths among cases | Incidence HR* (95%CI) | Death HR* (95%CI) | Survival HR* (95%CI) |
|---------------------------|------------------------|----------------|-----------------|-----------------------------|----------------------|------------------|---------------------|
| Highest                   | 9,872                  | 120            | 100             | 106                         | 1.23 (0.82–1.85)     | 0.91 (0.59–1.40) | 1.03 (0.89–1.20)    |
| p for trend               |                        |                |                 |                             | 0.426                | 0.545            | 0.681               |
| Pancreas (C25)            |                        |                |                 |                             |                      |                  |                     |
| Lowest                    | 10,532                 | 54             | 52              | 51                          | 1.00                 | 1.00             | 1.00                |
| Second                    | 10,713                 | 45             | 48              | 44                          | 0.85 (0.55–1.31)     | 0.92 (0.58–1.46) | 1.05 (0.95–1.15)    |
| Third                     | 9,766                  | 50             | 48              | 48                          | 1.13 (0.71–1.82)     | 1.13 (0.68–1.87) | 1.04 (0.95–1.15)    |
| Highest                   | 9,872                  | 39             | 35              | 33                          | 0.99 (0.52–1.87)     | 1.04 (0.55–1.96) | 0.92 (0.77–1.11)    |
| p for trend               |                        |                |                 |                             | 0.857                | 0.784            | 0.352               |
| Lung (C34)                |                        |                |                 |                             |                      |                  |                     |
| Lowest                    | 10,532                 | 232            | 183             | 193                         | 1.00                 | 1.00             | 1.00                |
| Second                    | 10,713                 | 236            | 184             | 203                         | 0.99 (0.80–1.22)     | 1.03 (0.80–1.31) | 1.10 (1.01–1.19)    |
| Third                     | 9,766                  | 193            | 155             | 167                         | 0.84 (0.65–1.08)     | 0.91 (0.68–1.21) | 1.11 (1.00–1.23)    |
| Highest                   | 9,872                  | 226            | 177             | 186                         | 0.88 (0.66–1.17)     | 0.87 (0.62–1.23) | 1.07 (0.94–1.21)    |
| p for trend               |                        |                |                 |                             | 0.321                | 0.344            | 0.532               |
| Prostate (C61)            |                        |                |                 |                             |                      |                  |                     |
| Lowest                    | 10,532                 | 164            | 20              | 46                          | 1.00                 | 1.00             | 1.00                |
| Second                    | 10,713                 | 169            | 27              | 45                          | 0.96 (0.75–1.23)     | 1.24 (0.63–2.43) | 0.90 (0.62–1.31)    |
| Third                     | 9,766                  | 219            | 27              | 64                          | 1.56 (1.18–2.07)     | 1.09 (0.62–2.27) | 0.93 (0.63–1.36)    |
| Highest                   | 9,872                  | 180            | 30              | 56                          | 1.04 (0.75–1.44)     | 0.77 (0.35–1.71) | 0.82 (0.50–1.34)    |
| p for trend               |                        |                |                 |                             | 0.598                | 0.254            | 0.457               |
| Localized                 |                        |                |                 |                             |                      |                  |                     |
| Lowest                    | 10,532                 | 108            | 16              | 1.00                         | 1.00                 |                  |                     |
| Second                    | 10,713                 | 91             | 15              | 0.90 (0.66–1.22)             | 1.11 (0.49–2.52)     |                  |                     |
| Third                     | 9,766                  | 117            | 14              | 1.60 (1.11–2.31)            | 0.61 (0.23–1.59)     |                  |                     |
| Highest                   | 9,872                  | 92             | 16              | 1.16 (0.75–1.80)            | 0.45 (0.14–1.39)     |                  |                     |
| p for trend               |                        |                |                 |                             | 0.281                | 0.113            |                     |
| Advanced                  |                        |                |                 |                             |                      |                  |                     |
| Lowest                    | 10,532                 | 57             | 30              | 1.00                         | 1.00                 |                  |                     |
| Second                    | 10,713                 | 79             | 30              | 1.05 (0.72–1.53)            | 0.83 (0.63–1.35)     |                  |                     |
| Third                     | 9,766                  | 102            | 50              | 1.52 (1.01–2.27)            | 1.20 (0.76–1.87)     |                  |                     |
| Highest                   | 9,872                  | 88             | 40              | 0.95 (0.58–1.54)            | 1.43 (0.78–2.62)     |                  |                     |
| p for trend               |                        |                |                 |                             | 0.679                | 0.148            |                     |

*Adjusted for age (age at diagnosis for cancer survival), area, population density (quartile), occupation (professionals and office worker, sales clerks or others, farmers, manual labors and others), smoking, alcohol drinking, body mass index, and leisure-time sport activity.

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Table 4. Deprivation index and cancer risk in women (n = 45,229).

| Deprivation Index Quartile | Number of participants | Number of cases | Number of deaths | Number of deaths among cases | Incidence HR* (95%CI) | Death HR* (95%CI) | Survival HR* (95%CI) | p for trend |
|-----------------------------|------------------------|-----------------|------------------|-----------------------------|-----------------------|------------------|---------------------|------------|
| All sites                   | 4,056                  | 1,603           | 1,832            |                             |                       |                  |                     |            |
| Lowest                      | 11,121                 | 970             | 403              | 453                         | 1.00                  | 1.00             | 1.00                |            |
| Second                      | 11,686                 | 1,061           | 415              | 465                         | 1.00 (0.92–1.10)       | 1.01 (0.88–1.16)  | 0.99 (0.90–1.09)   |            |
| Third                       | 11,126                 | 961             | 377              | 432                         | 0.98 (0.88–1.09)       | 0.96 (0.81–1.14)  | 0.96 (0.85–1.08)   |            |
| Highest                     | 11,296                 | 1,064           | 408              | 482                         | 0.98 (0.86–1.12)       | 0.99 (0.81–1.22)  | 1.01 (0.87–1.17)   |            |
| p for trend                 |                        |                 |                  |                             | 0.760                  | 0.866            | 0.861               |            |
| Stomach (C16)               | 576                    | 199             | 234              |                             |                       |                  |                     |            |
| Lowest                      | 11,121                 | 176             | 54               | 70                          | 1.00                  | 1.00             | 1.00                |            |
| Second                      | 11,686                 | 162             | 57               | 60                          | 1.00 (0.79–1.26)       | 1.32 (0.92–1.88)  | 1.09 (0.83–1.43)   |            |
| Third                       | 11,126                 | 116             | 47               | 51                          | 0.97 (0.72–1.31)       | 1.53 (0.96–2.43)  | 1.37 (0.96–1.95)   |            |
| Highest                     | 11,296                 | 122             | 41               | 53                          | 1.17 (0.81–1.69)       | 1.70 (0.94–3.09)  | 1.43 (0.90–2.25)   |            |
| p for trend                 |                        |                 |                  |                             | 0.411                  | 0.069            | 0.124               |            |
| Colorectum (C18–C20)        | 777                    | 213             | 265              |                             |                       |                  |                     |            |
| Lowest                      | 11,121                 | 195             | 59               | 70                          | 1.00                  | 1.00             | 1.00                |            |
| Second                      | 11,686                 | 209             | 52               | 60                          | 1.01 (0.83–1.22)       | 0.69 (0.43–1.13)  | 0.80 (0.57–1.11)   |            |
| Third                       | 11,126                 | 169             | 47               | 58                          | 0.85 (0.66–1.10)       | 0.51 (0.29–0.89)  | 0.71 (0.48–1.04)   |            |
| Highest                     | 11,296                 | 204             | 55               | 72                          | 0.85 (0.63–1.15)       | 0.49 (0.26–0.90)  | 0.75 (0.48–1.16)   |            |
| p for trend                 |                        |                 |                  |                             | 0.233                  | 0.029            | 0.244               |            |
| Colon (C18)                 | 536                    | 134             | 167              |                             |                       |                  |                     |            |
| Lowest                      | 11,121                 | 138             | 37               | 45                          | 1.00                  | 1.00             | 1.00                |            |
| Second                      | 11,686                 | 142             | 35               | 42                          | 1.03 (0.80–1.32)       | 0.86 (0.48–1.53)  | 0.92 (0.63–1.33)   |            |
| Third                       | 11,126                 | 108             | 24               | 31                          | 0.91 (0.65–1.25)       | 0.53 (0.25–1.12)  | 0.70 (0.44–1.11)   |            |
| Highest                     | 11,296                 | 148             | 38               | 49                          | 1.03 (0.72–1.47)       | 0.65 (0.31–1.37)  | 0.78 (0.48–1.27)   |            |
| p for trend                 |                        |                 |                  |                             | 0.027                  | 0.274            | 0.277               |            |
| Rectum (C19–C20)            | 241                    | 79              | 98               |                             |                       |                  |                     |            |
| Lowest                      | 11,121                 | 57              | 22               | 25                          | 1.00                  | 1.00             | 1.00                |            |
| Second                      | 11,686                 | 67              | 17               | 23                          | 0.93 (0.61–1.42)       | 0.46 (0.21–0.99)  | 0.47 (0.24–0.92)   |            |
| Third                       | 11,126                 | 61              | 23               | 27                          | 0.73 (0.46–1.18)       | 0.44 (0.19–1.02)  | 0.49 (0.23–1.05)   |            |
| Highest                     | 11,296                 | 56              | 17               | 23                          | 0.54 (0.32–0.92)       | 0.28 (0.10–0.76)  | 0.45 (0.19–1.07)   |            |
| p for trend                 |                        |                 |                  |                             | 0.010                  | 0.029            | 0.287               |            |
| Liver (C22)                 | 189                    | 139             | 158              |                             |                       |                  |                     |            |
| Lowest                      | 11,121                 | 38              | 31               | 36                          | 1.00                  | 1.00             | 1.00                |            |
| Second                      | 11,686                 | 50              | 38               | 41                          | 1.48 (0.93–2.37)       | 1.51 (0.89–2.54)  | 0.89 (0.75–1.06)   |            |
| Third                       | 11,126                 | 51              | 36               | 41                          | 1.89 (1.13–3.15)       | 1.95 (1.06–3.58)  | 0.89 (0.71–1.11)   |            |

Table 4. Deprivation index and cancer risk in women (n = 45,229).
| Table 4. Cont. |
|----------------|
| **Deprivation Index Quartile** | **Number of participants** | **Number of cases** | **Number of deaths** | **Number of deaths among cases** | **Incidence** | **Death** | **Survival** |
| | | | | | **HR** (95%CI) | **HR** (95%CI) | **HR** (95%CI) |
| **Pancreas (C25)** | | | | | | |
| Highest | 11,296 | 50 | 34 | 40 | 1.78 (0.94– 3.36) | 1.90 (0.97– 3.72) | 0.90 (0.64– 1.27) |
| *p for trend* | | | | | 0.105 | 0.072 | 0.344 |
| Lowest | 11,121 | 46 | 44 | 42 | 1.00 | 1.00 | 1.00 |
| Second | 11,686 | 42 | 42 | 41 | 0.75 (0.46– 1.22) | 0.74 (0.45– 1.23) | 1.02 (0.94– 1.11) |
| Third | 11,126 | 45 | 41 | 44 | 0.77 (0.43– 1.36) | 0.67 (0.38– 1.17) | 1.02 (0.89– 1.17) |
| **Lung (C34)** | | | | | | |
| Highest | 11,296 | 39 | 36 | 37 | 0.81 (0.43– 1.52) | 0.76 (0.40– 1.46) | 1.03 (0.86– 1.22) |
| *p for trend* | | | | | 0.672 | 0.524 | 0.818 |
| Lowest | 11,121 | 79 | 40 | 43 | 1.00 | 1.00 | 1.00 |
| Second | 11,686 | 79 | 45 | 51 | 0.74 (0.53– 1.03) | 0.99 (0.65– 1.52) | 1.37 (1.01– 1.86) |
| Third | 11,126 | 87 | 48 | 50 | 0.80 (0.54– 1.19) | 0.99 (0.58– 1.69) | 1.11 (0.79– 1.56) |
| **Breast (C50)** | | | | | | |
| Highest | 11,296 | 106 | 63 | 62 | 0.76 (0.48– 1.21) | 1.04 (0.35– 1.95) | 1.21 (0.83– 1.77) |
| *p for trend* | | | | | 0.467 | 0.876 | 0.732 |
| Lowest | 11,121 | 165 | 30 | 38 | 1.00 | 1.00 | 1.00 |
| Second | 11,686 | 172 | 27 | 34 | 1.03 (0.80– 1.31) | 0.98 (0.57– 1.68) | 0.97 (0.64– 1.47) |
| Third | 11,126 | 161 | 28 | 39 | 1.09 (0.83– 1.42) | 1.08 (0.47– 2.49) | 1.02 (0.59– 1.75) |

*Adjusted for age (age at diagnosis for cancer survival), area, population density (quartile), occupation (professionals and office worker, sales clerks or others, farmers, manual labors and others), smoking, alcohol drinking, body mass index, and leisure-time sport activity.
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individual deprivation such as occupation is more sensitive in detecting the association between deprivation and cancer than JDI in Japan.

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