Socioeconomic inequalities in cancer: using population-based cancer registry data and vital statistics

がんにおける社会経済指標による格差: がん登録、人口動態統計を用いた解析

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Health inequalities

- Inequalities in health is global concern.
- Most developed countries monitor the health inequalities using official statistics.
In Japan…

The target of the second edition of Healthy Japan 21 was “Reduce the health inequalities”
Socioeconomic status (SES)  Health outcome

e.g. Income, Occupation, Education  e.g. mortality, incidence, survival

Ideally...

Individual record linkage between SES and Health outcome is needed.
To evaluate the causal relationship of those, cohort study is desirable.
For health policy, we need to monitor long-term trends of socioeconomic inequalities by using routinely collected data, covering all population.

However...

In Japan, individual linkage between SES and Health outcome using official statistics has not been implemented yet.
Background

• Long-term economic recession in Japan
  → Growing social inequalities
  → Inequalities appeared in health
• The target of the second edition of Healthy Japan 21 was “Reduce the health inequalities”
• The 3rd Osaka Cancer Plan is following the target
• But the system to monitor the health inequalities has not been established yet

Objectives

• Monitor the socioeconomic inequalities in cancer using population-based data Japan
Cancer Control Continuum

Trends in incidence and mortality

% of early stage diagnosis

Prevention → Screening → Diagnosis → Treatment → Cure

Cancer registry data is important to evaluate cancer control activities

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Cancer Outcome

- Mortality
  - Total impact on the society
- Incidence
  - Risk factor
  - Screening
- Survival
  - Cancer Care

Vital statistics, 人口動態統計
Population-based Cancer Registry がん登録が必要！
Inequalities in cancer

• Gaps between...
  o Gender
  o Age
  o Area
    • Prefecture, second medical area
  o Socio-economic status (SES)
    • Areal deprivation gap
Areal deprivation index

• The small areas based on patients’ address linkage

  o Family type: Proportion of elderly couples, elderly singles and mother-child family
  o Housing type: Proportion of rented accommodation
  o Occupation type: Proportion of Clerical, Sales, Agriculture, Production/Labour, and Unemployed

• Areal deprivation index (0-100) were divided into quintiles (Q1: least deprived, ..., Q5: most deprived)

  \texttt{xtile dep5x = dep [fw=pop_all], nq(5)}
Areal Deprivation Index: ADI

- JGSS (Sample survey)
- National Census

Areal-level deprivation index were estimated by using same items in two database

Incidence and survival:
address of patients from cancer registry data
(Cho-Aza level, small)

Mortality:
Vital statistics
(municipality level, large)

merge 1:1 citycode


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Socioeconomic inequalities in Cancer Survival in Osaka, Japan

Data sources

• Osaka Cancer registry
• 237,848 patients who were diagnosed as major 13 sited of cancer in 1993-2004
  Esophagus, Stomach, Colorectum, Liver, Gallbladder, Pancreas, Larynx, Lung, Breast, Cervix uteri, Corpus uteri, Ovary, Prostate, Bladder
• Linked to the ADI based on the patients address (Cho-Aza level)
Methods

• Net survival: 1-year, 5-year and Conditional 5-year
  o Pohar-Perme estimates stns (SJ14-1: st0326)
  o By sex, cancer site, period at diagnosis, quintile of ADI

• Variance-weighted least square regression model
  Model 1
  \[ NS_{ij} = \beta_{per}p_i + \beta_{dep}d_j + e_{ij} \]

  Model 2
  \[ NS_{ij} = \beta_{per}p_i + \beta_{dep}d_j + \beta_{perdep}p_i d_j + e_{ij} \]

  NS: net survival
  \( p_i = 1,2,3 \) (period at diagnosis),
  \( d_j = 1,2,3,4,5 \) (Quintile deprivation group)
Net survival curves by quintile of ADI
Stomach cancer, male, 1993-1996

ADI quintile
1 Least deprived
2
3
4
5 Most deprived

Socio-Economic Status (SES)
High
Low

Net survival (%)
0 20 40 60 80 100

Years since diagnosis
0 1 2 3 4 5
Deprivation gap in 1-year and 5-year net survival in Osaka, Japan: 1993-2004

1-year net survival (Men)

1-year net survival (Women)

5-year net survival (Men)

5-year net survival (Women)

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Figure 1a. Deprivation gap in one-year net survival

General life tables

<table>
<thead>
<tr>
<th>Men</th>
<th>Women</th>
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</thead>
<tbody>
<tr>
<td>Pancreas</td>
<td>Pancreas</td>
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<tr>
<td>Lung</td>
<td>Liver</td>
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<td>Esophagus</td>
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<td>Stomach</td>
<td>Liver</td>
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<tr>
<td>Colorectum</td>
<td>Liver</td>
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<tr>
<td>Bladder</td>
<td>Liver</td>
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<td>Larynx</td>
<td>Liver</td>
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<tr>
<td>Prostate</td>
<td>Liver</td>
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<td>Ovary</td>
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<tr>
<td>Cervix</td>
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<tr>
<td>Uterus</td>
<td>Liver</td>
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<tr>
<td>Breast</td>
<td>Liver</td>
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</tbody>
</table>

Absolute deprivation gap (%)

One-year net survival

Two-way scatter & rcap

lfit

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Figure 1b. Deprivation gap in five-year net survival
General life tables

<table>
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</tr>
<tr>
<td>Breast</td>
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</tbody>
</table>

Absolute deprivation gap (%) vs. Five-year net survival.
Figure 1c. Deprivation gap in conditional five-year net survival

General life tables

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<tr>
<td>Colorectum</td>
<td>Colorectum</td>
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<tr>
<td>Larynx</td>
<td>Larynx</td>
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<tr>
<td>Prostate</td>
<td>Prostate</td>
</tr>
</tbody>
</table>

Conditional five-year net survival

Absolute deprivation gap (%)

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Change of deprivation gap in period at diagnosis

- Reduced gap
  - Pancreatic cancer in men: 1-year net survival
  - Stomach cancer in women: 1-year net survival

- Widened gap
  - Lung cancer in men: 1- and 5-year net survival

- No change in other cancer sites
Summary:

depression gap in cancer survival

- Wider gaps were observed in cancer sites which can be earlier detected
  - Differences in % of screened
  - Deprived people diagnosed at later stage
- Not so many changes in deprivation gap
  -> Need to monitor after 2005
    (started widening economic gap)
- Further studies for differences in cancer care access and the treatment (cost) were needed
  -> Need to record linkage
Socio-economic differences in stage-specific cancer incidence in Osaka, Japan: 1993-2004

Ito Y, Nakaya T, Kondo N et al (in preparation)
Why Stage-specific incidence?

• Variation in cancer incidence related to prevalence of cancer risk factor and early diagnosis

• Early diagnosis of cancer was influenced by
  o Better access to screening programmes
  or
  o Awareness of cancer symptoms

• When we monitor socio-economic differences in cancer incidence, we need to monitor early- and late-stage incidence separately to consider the influence of early detection

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Methods

• 164,402 cases: stomach, colorectal, lung, breast, cervical and prostate cancer
• Osaka Cancer Registry, Japan (Pop. 8.8 mil.)

**dstdize**

• **Age-standardised incidence rate** (Std.Pop. 1985)
  o Stage at diagnosis (SEER summary stage 2000)
    • Early stage: Localised
    • Late stage: Regional and Distant metastasis
  o Socio-economic status: Areal deprivation index
1. We applied variance weighted least square regression

2. Deprivation gap = Absolute difference between Q5 – Q1

3. Examined change in gap using interaction between deprivation and period
Stomach

Men

Women

twoway bar & line

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Lung

Men

twoway bar & line

Women
Summary of deprivation gap: Men

twoway bar & rcap

* p<0.05 for interaction of period and deprivation index
Summary of deprivation gap: Women

twoway bar & rcap

* p<0.05 for interaction of period and deprivation index

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Summary of results

• Late stage incidence
  o More deprived patients > less deprived patients, except for prostate cancer
  o Gaps became narrower

• Early stage incidence
  o Less deprived patients > more deprived patients, especially for male stomach, colorectal, prostate cancer
  o Gaps became wider during recent period

• Cervical cancer for both stages
  o More deprived patients > less deprived patients
Possible explanation

- Inverse contrast of early stage incidence in men
  - Difference in the screening type related to working place (Health insurance is determined the style of cancer screening in Japan)
- High-risk health behaviour in deprived group
  - Tobacco smoking, risky sexual activities
  - Less participation to the screening
  - Lack of awareness and delay in access to cancer care
Socioeconomic Inequalities in Cancer Mortality in Japan
Data Sources

• Vital statistics data for the period between 2005 and 2014, including residential area (municipality-level)
• Population data by sex, 5-year age group and municipality: National Census for 2006 and 2010
  -> Population data for other years were interpolated/extrapolated
• The areal deprivation index (ADI):

merge 1:1 citycode
Trends in all cancers by ADI quintile

Cancer: 0-84 years old
1995-2014

Male

Q5: Most deprived

Q1: Least deprived

Female

Age-standardised mortality rate/100,000

Year

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Statistical Analysis

1. Age-standardised mortality rate (ASMR) by quintile group of ADI
   -> Absolute differences Q5 and Q1 ASMR
   -> Attributable fraction of each cause of death

2. Relative risks (RR) of Q1 (ref) to Q2-Q5 estimated by Poisson regression model

\[
O_i \sim \text{Poisson}(\lambda_i E_i) \quad i : \text{municipality}, \quad \lambda_i \quad \text{quintile}
\]

\[
\log(\lambda_i) = \alpha + \sum_{k=2}^{5} \beta_k d_{epik}.
\]

\[
RR_k = \exp(\beta_k) \quad (k = 2, \ldots, 5)
\]

*glm* obs dep2-dep5, family(poisson) link(log) offset(lnexp) eform

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Socio-Economic Position (SEP)

\[ \text{ADI} \]

\[ \text{egen sumpop} = \text{sum(pop)} \]
\[ \text{gen csumpop} = \text{sum(pop)} \]

\[ p_i \]
\[ p_i / 2 \]

\[ \text{SEP}_i \]

\( i \): municipality
\( p_i \): proportion of municipality \( i \)

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Statistical Analysis

3. Relative Index of Inequalities (RII) by year

\[ \log(\lambda_i) = \alpha + \beta \cdot SEP_i \]

\[ RII = \exp(\alpha + \beta) / \exp(\alpha) = \exp(\beta) \]

glm obs sepi, family(poisson) link(log)
offset(lnexp) eform
gen coef_sepi=_b[sepi]
gen se_sepi=_se[sepi]
gen rr_sepi=exp(coef_sepi)
gen rr_cil_sepi=exp(coef_sepi-1.96*se_sepi)
gen rr_ciu_sepi=exp(coef_sepi+1.96*se_sepi)
Statistical Analysis

4. Trends in RII using interaction term

\[ \log(\lambda_{ij}) = \alpha + \beta \cdot SEP_i + \gamma \cdot \text{period}_j + \delta \cdot SEP_i \cdot \text{period}_j \]

```
glm obs sepi i.cnyear i.cnyear##c.sepi
if sex==`g', family(poisson) link(log)
offset(lnexp) eform
```
Standardised Mortality Ratios (SMRs) of All sites of cancer death by ADI in Japan in 2006-2014

Male

Female

* p<0.05 for interaction between ADI and period

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Standardised Mortality Ratios (SMRs) of ADI group (ref: Q1) in Japan in 2006-2014: Male

- Oesophagus
- Stomach
- Colorectum
- Liver
- Pancreas
- Larynx
- Lung
- Prostate
- Lymphoma
- Leukaemia

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Standardised Mortality Ratios (SMRs) of ADI group (ref: Q1) in Japan in 2006-2014: Female

- Oesophagus
- Stomach
- Colorectum
- Liver
- Pancreas
- Lung
- Breast
- Cervix uteri
- Corpus uteri
- Ovary
- Lymphoma
- Leukaemia

*twoway bar & rcap*
Discussion

• Wider gaps in cancer mortality between the most and the least deprived in men were observed than those in women.

• Deprivation gaps were wide in Liver, Lung, Cervical cancers and Leukaemia.
  o Liver: Less access to treatment for Hepatitis virus C.
  o Lung: Higher smoking rate in the more deprived group.
  o Cervix: Lower attendance rate of cancer screening.
  o Leukaemia: Regional effect? (e.g. High incidence in the west part of Japan), Expensive and long-term treatment? (e.g. Born-marrow transplant).

• Inverse contrast was observed in Breast, Corpus uteri and Ovarian cancer.
  o Related to the high risk lifestyle in the less deprived group? (reproductive factor, alcohol consumption).
Long-term trends in Relative Index of Inequalities (RII)

Cancer

Trends in RII by age group

twoway scatter & rcap

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Limitation of our data availability

- Socioeconomic status is based on areal level
  - The size of area is large for mortality data
    -> under estimate of deprivation gap
  - Different area: National Census and Cancer Registry (time consuming to adjust the difference)
    -> use exact address to translate a geocode
- In near future, we need to link the National Census and Cancer Registry/Vital Statistics via individual ID
Further steps to reduce deprivation gap

- Monitor deprivation gap in cancer outcome and related factors in all prefectures in Japan
  - Survival, stage-specific incidence, mortality, smoking rate, screening rate
- Try to understand the mechanism of the deprivation gap
- Take measures to reduce the gap

Causal mediation analysis
Gformula, paramed,...
Model simulation
Thank you for your attention!

Please keep in touch to discuss with Stata and the useful command.

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