



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

Yuri Ito

Senior Researcher

Cancer Control Center

Osaka International Cancer Institute

伊藤ゆり

主任研究員

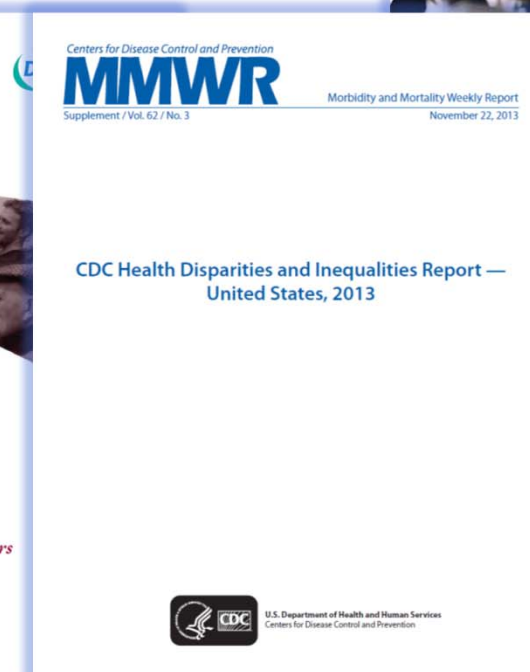
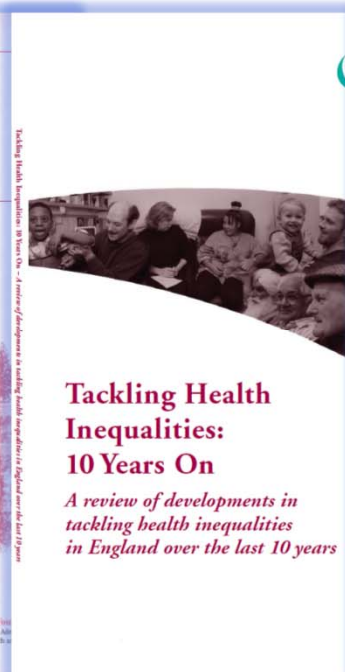
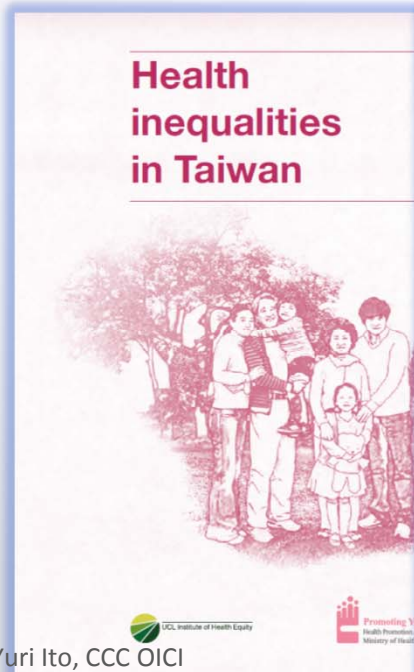
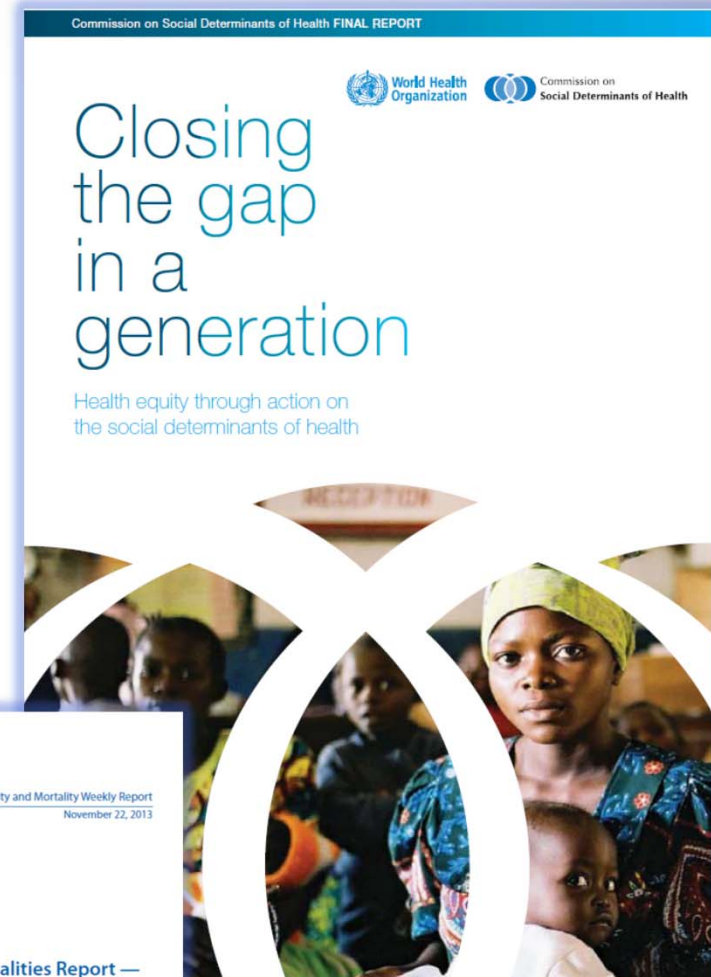
大阪国際がんセンター

がん対策センター

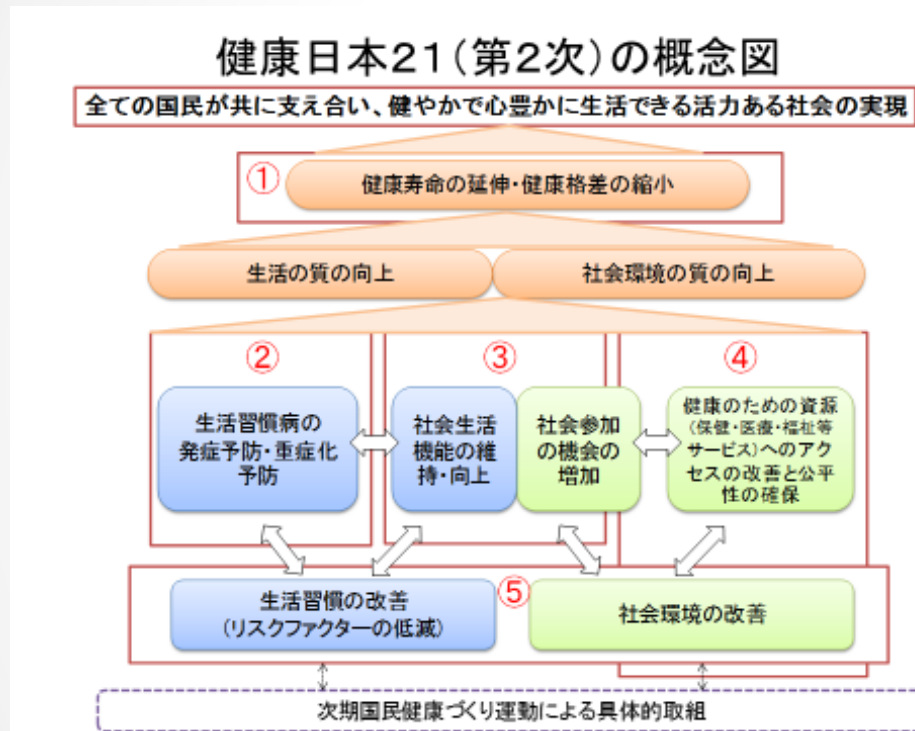


Health inequalities

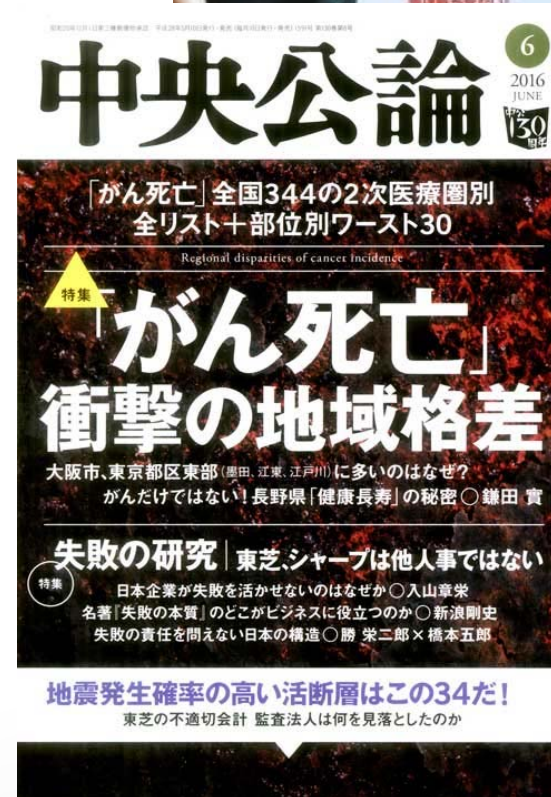
- Inequalities in health is global concern.
- Most developed countries monitor the health inequalities using official statistics.



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

看取りの場所

Prevention

Screening

Diagnosis

Treatment

Palliative care

Cure

がんにならない

早く見つける

確実に診断

がん医療の
均てん化

(就労支援)

たばこ対策
肝炎対策

がん検診
胃・大腸・肺
乳房・子宮頸

要精検者を
精密検査に

Cancer Survival & Cure fraction

Cancer registry data is important
to evaluate cancer control activities

Cancer Outcome

- Mortality

Vital statistics , 人口動態統計

- Total impact on the society

- Incidence

- Risk factor
- Screening

- Survival

- Cancer Care



Population-based Cancer Registry
がん登録が必要！

Inequalities in cancer

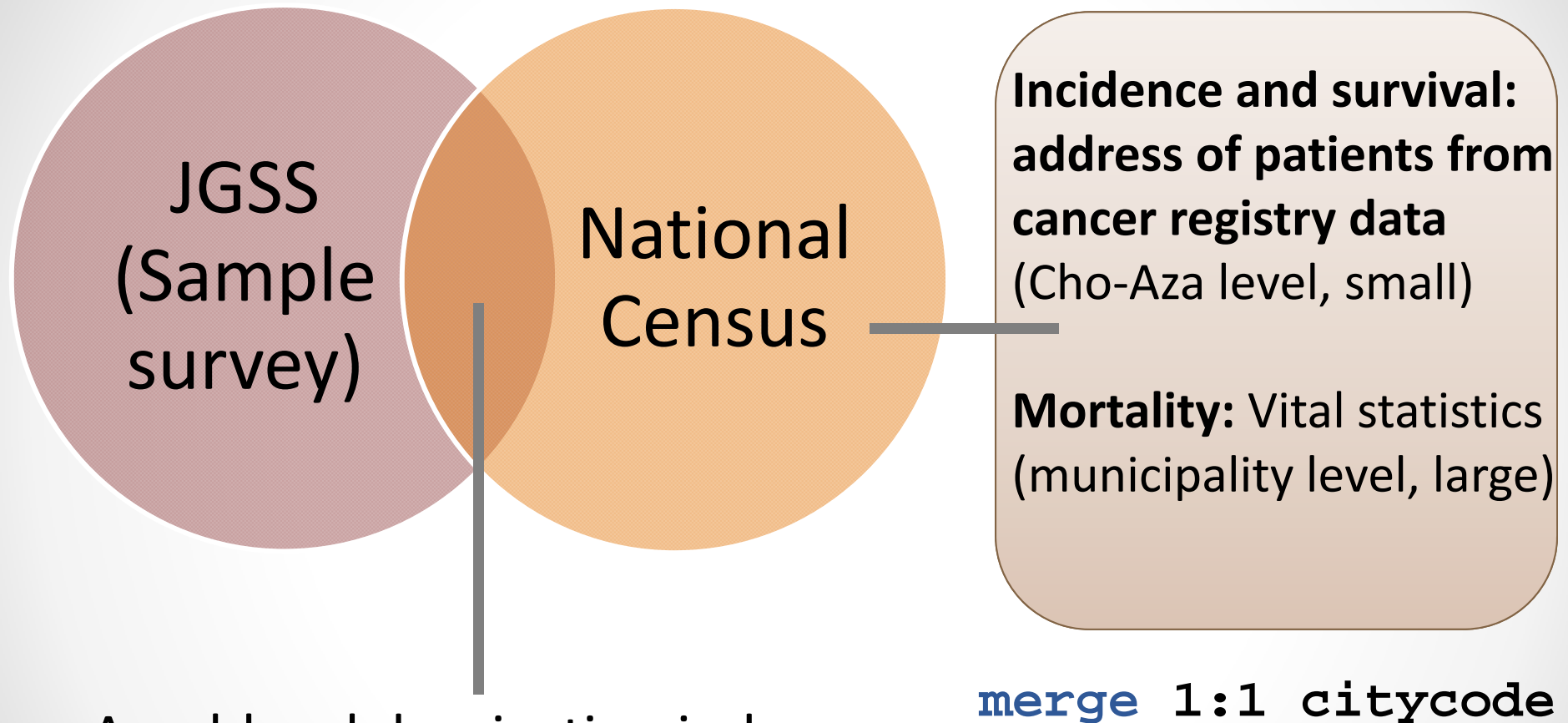
- Gaps between...
 - Gender
 - Age
 - Area
 - Prefecture, second medical area
 - Socio-economic status (SES)
 - Areal deprivation gap

Areal deprivation index

- The small areas based on patients' address
↕ linkage
- Estimated by areal aggregated census-based information: Nakaya et al. PLoS One. 2014
 - Family type: Proportion of elderly couples, elderly singles and mother-child family
 - Housing type: Proportion of rented accommodation
 - 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)

```
xtile dep5x = dep [fw=pop_all], nq(5)
```

Areal Deprivation Index : ADI



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

`merge 1:1 citycode`

Nakaya et al. PLoS One. 2014

Socioeconomic inequalities in Cancer Survival in Osaka, Japan

...

Ito Y, Nakaya T, Nakayama T, et al. Acta Oncol. 2014;53:1423-33.

Data sources

- Osaka Cancer registry
- 237,848 patients who were diagnosed as major 13 sites 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
 - Pohar-Perme estimates `stns (SJ14-1: st0326)`
 - By sex, cancer site, period at diagnosis, quintile of ADI

- Variance-weighted least square regression model

Model 1

$$NS_{ij} = \beta_{per}p_i + \beta_{dep}d_j + e_{ij}$$

`vwls`

`est store`

`& estout`

Model 2

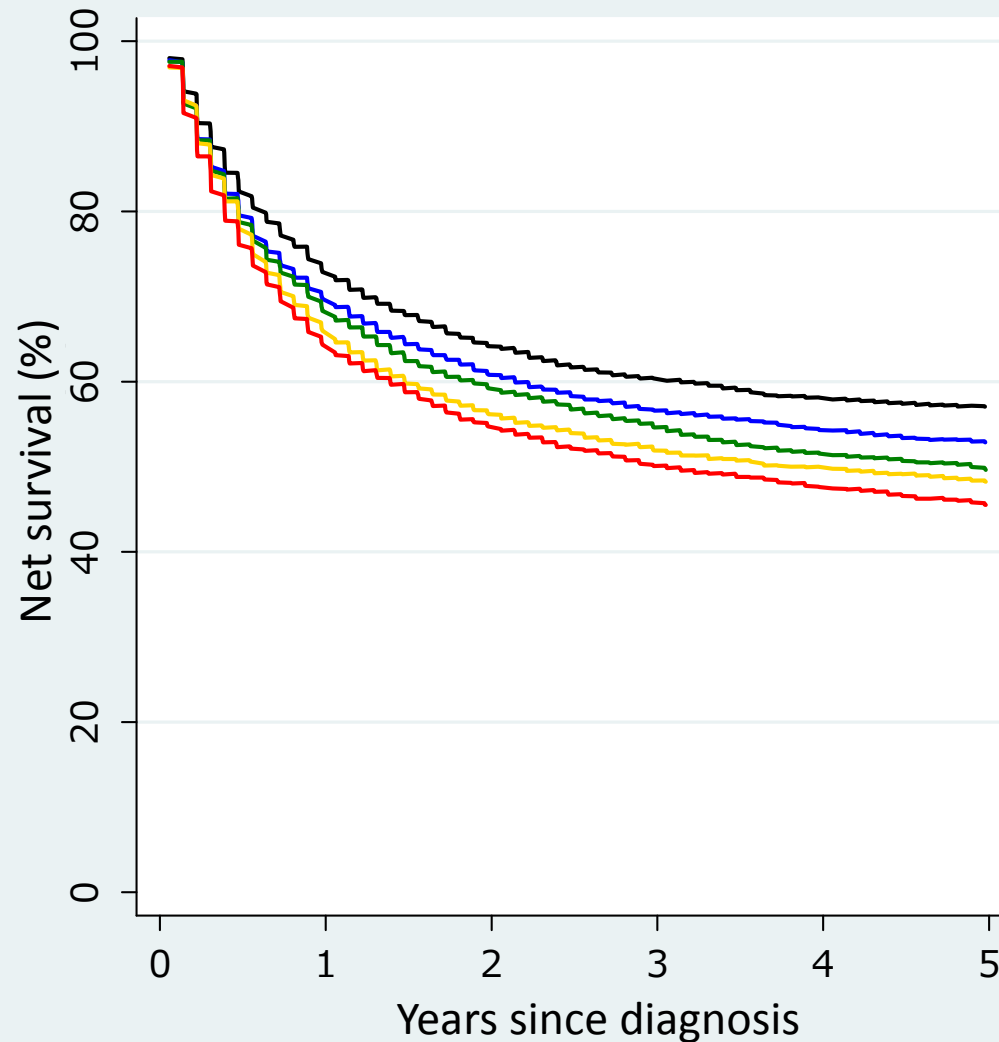
$$NS_{ij} = \beta_{per}p_i + \beta_{dep}d_j + \beta_{perdep}p_id_j + e_{ij}$$

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

Deprivation gap in 1-year and 5-year net survival in Osaka, Japan: 1993-2004

twoway bar & rcap

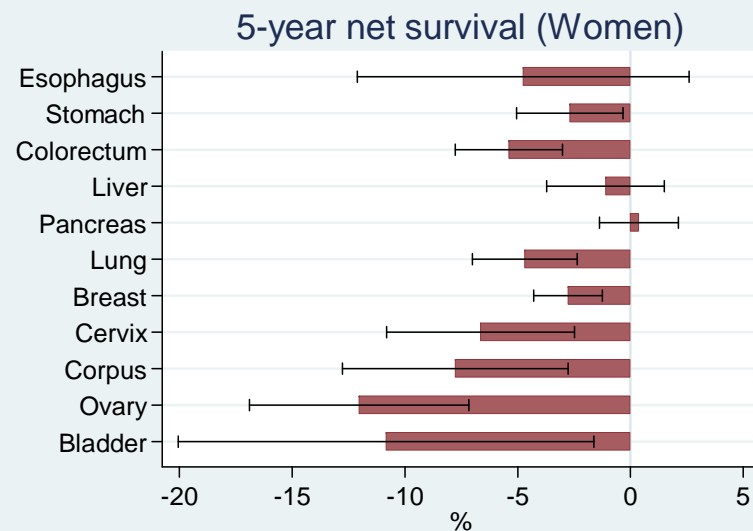
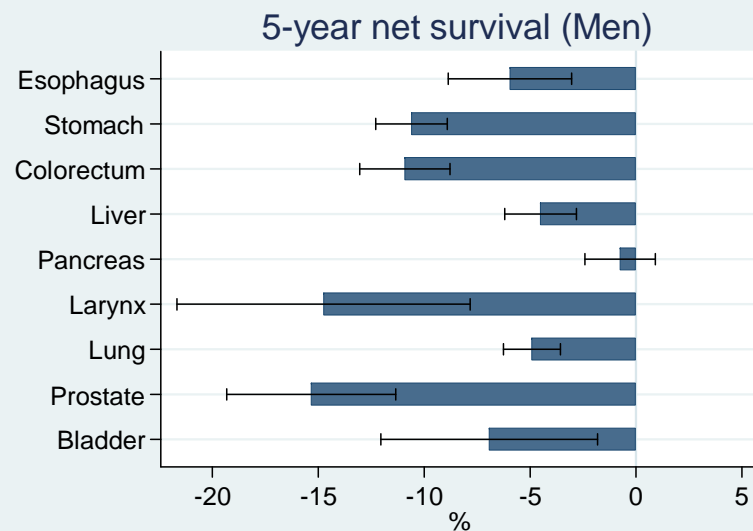
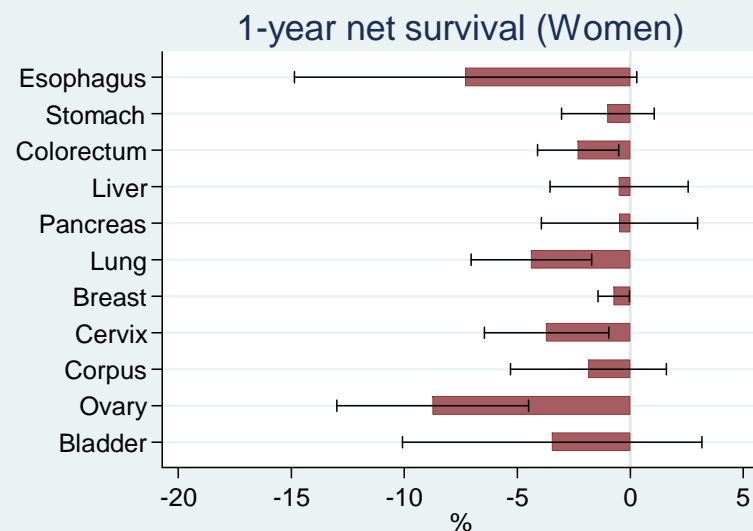
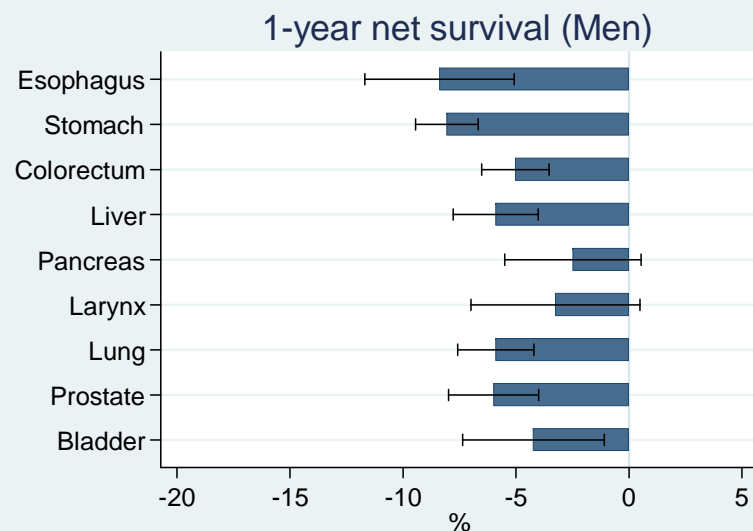


Figure 1a. Deprivation gap in one-year net survival
General life tables



`twoway scatter & rcap
lfit`

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

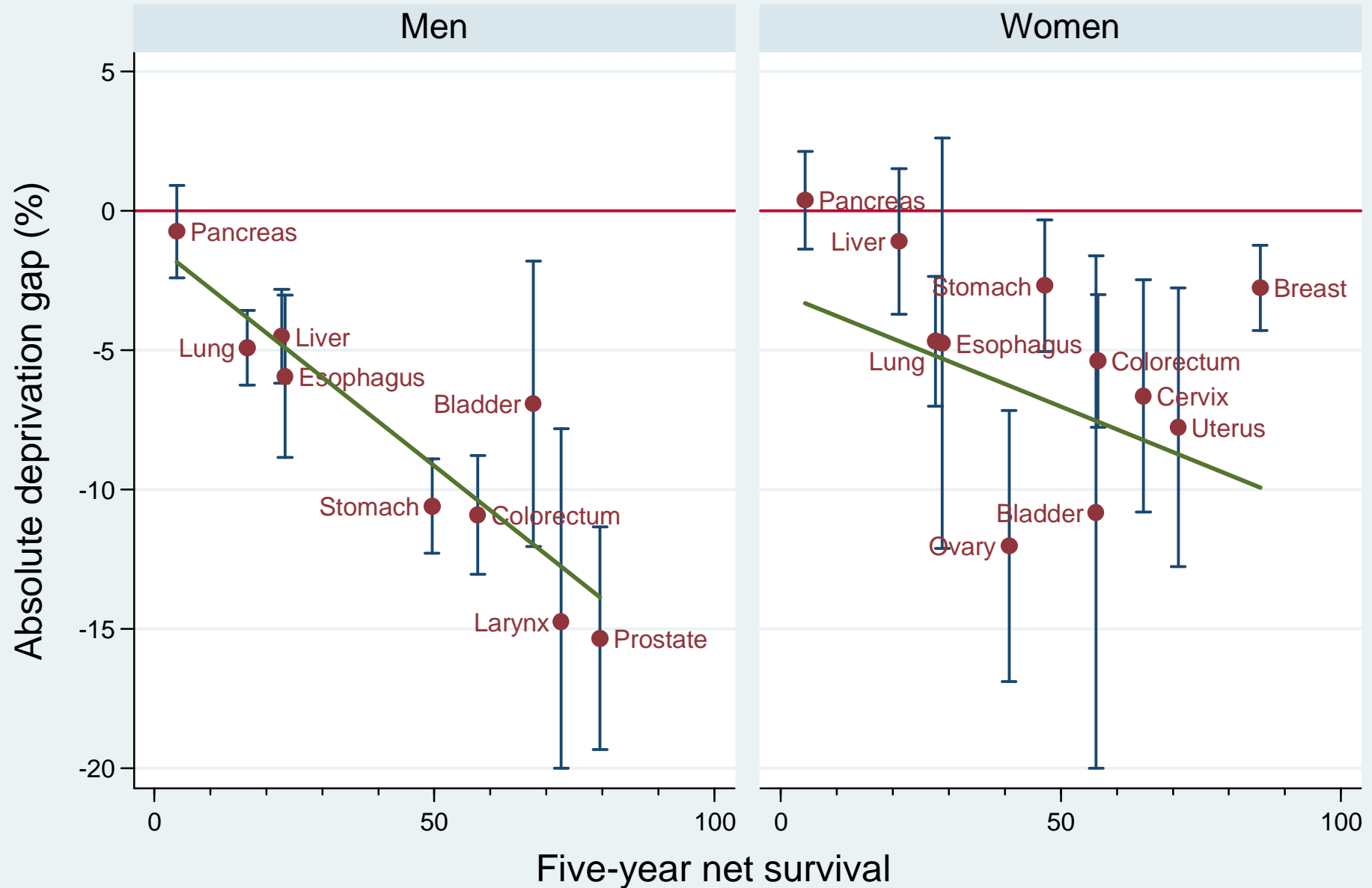
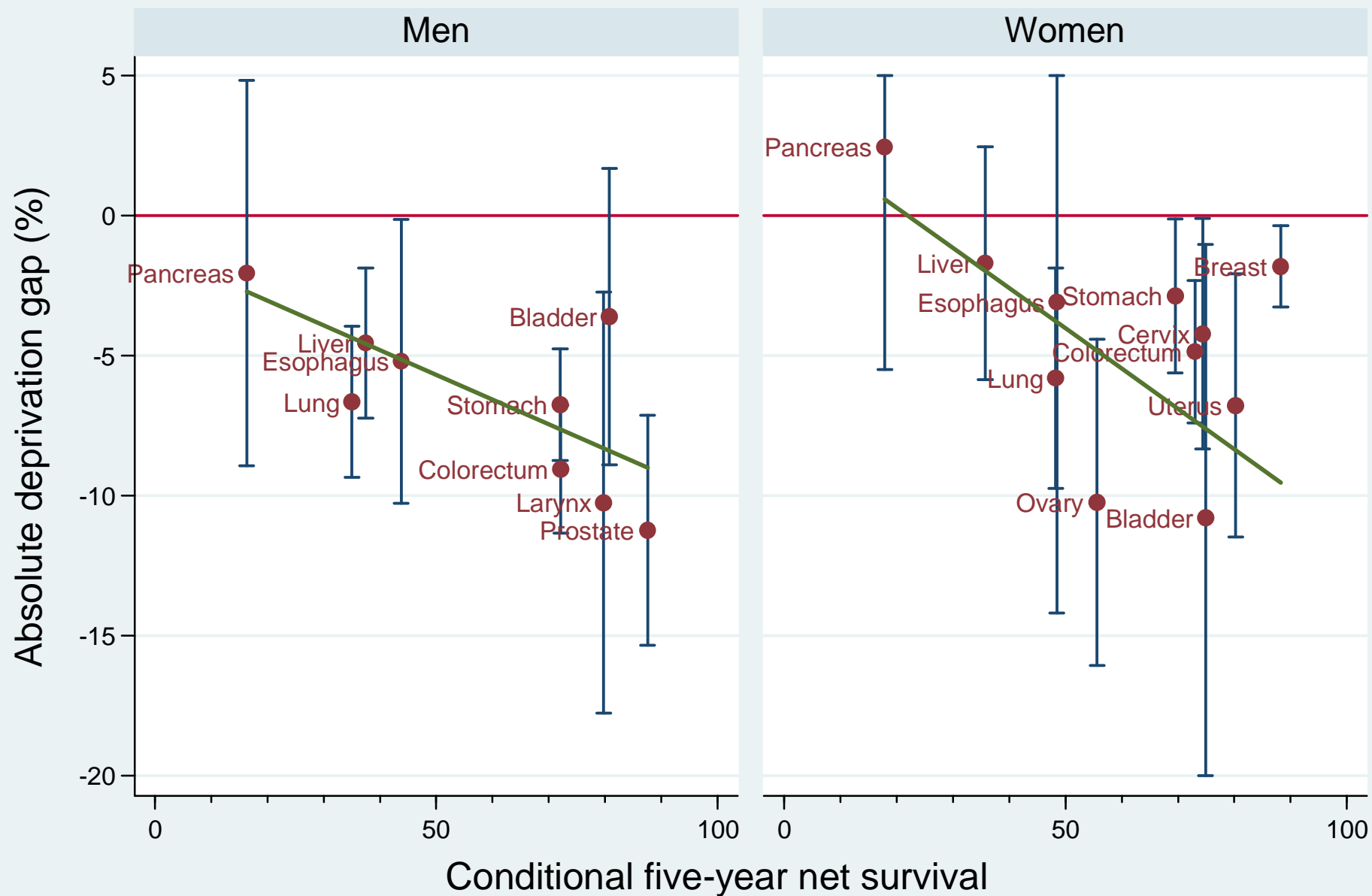


Figure 1c. Deprivation gap in conditional five-year net survival
General life tables



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:

deprivation gap in cancer survival

- Wider gaps were observed in cancer sites which can be earlier detected
 - Differences in % of screened
Tabuchi et al. Nihon-Iji-Shinpo (in Japanese). (4605), 84-88, 2012-7-28
 - 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
 - Better access to screening programmes
 - or
 - 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



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)
 - Period at diagnosis: 1993-1998/1999-2004
 - Stage at diagnosis (SEER summary stage 2000)
 - Early stage: Localised
 - Late stage: Regional and Distant metastasis
 - Socio-economic status: Areal deprivation index

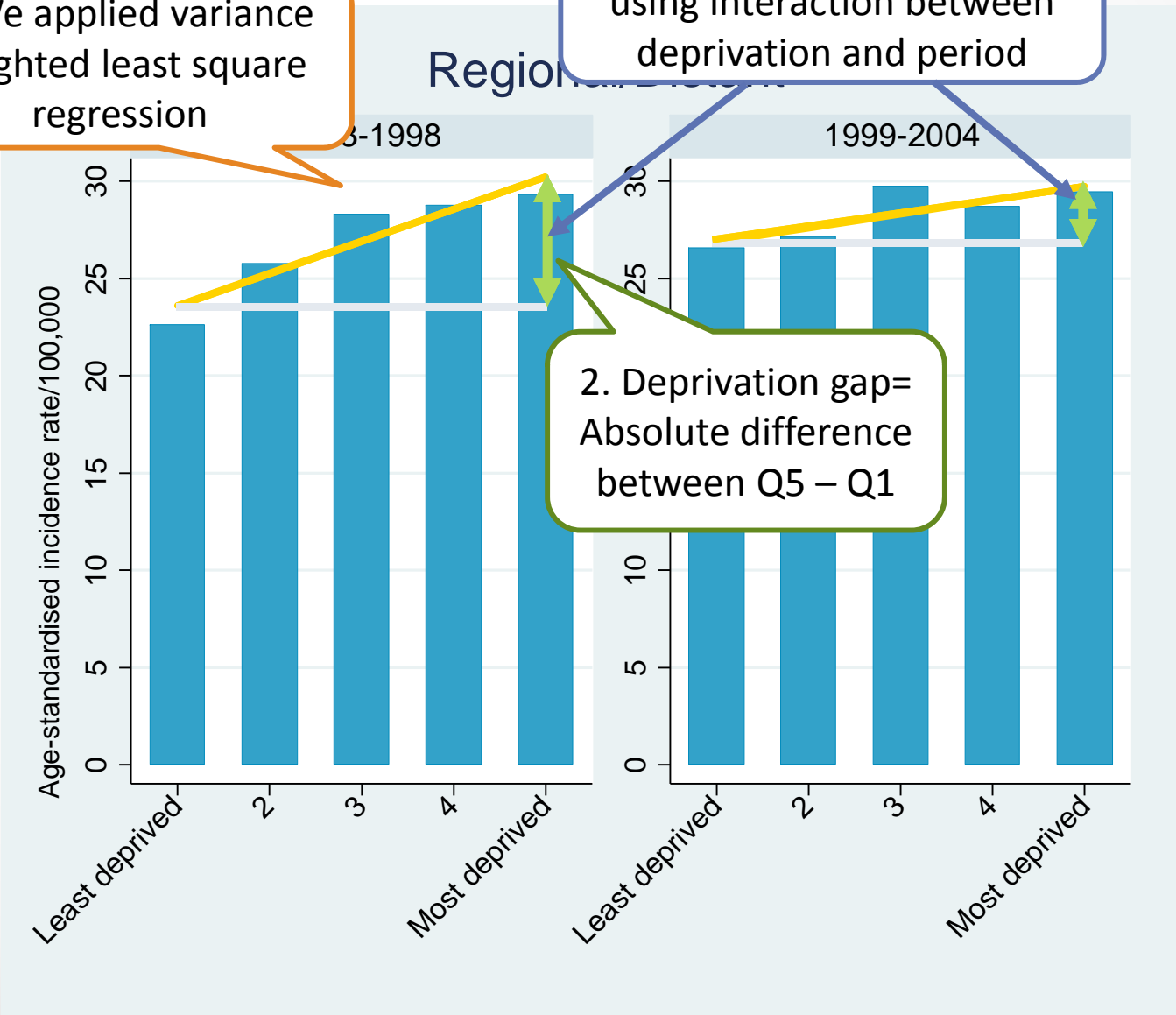
Deprivation gap

vwls

1. We applied variance weighted least square regression

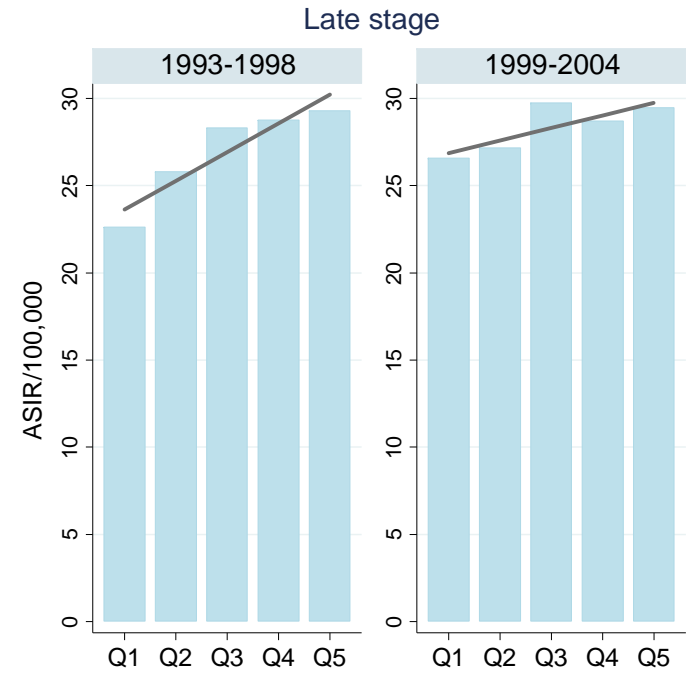
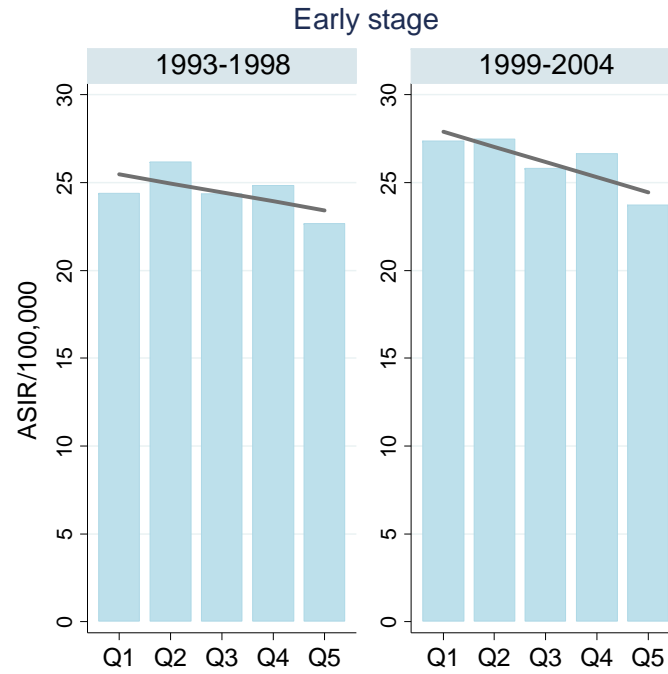
3. Examined change in gap using interaction between deprivation and period

2. Deprivation gap = Absolute difference between Q5 – Q1



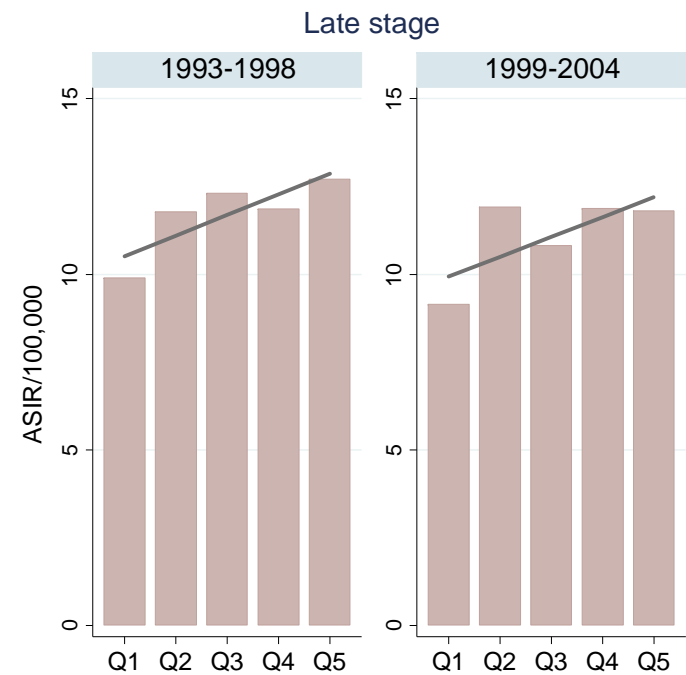
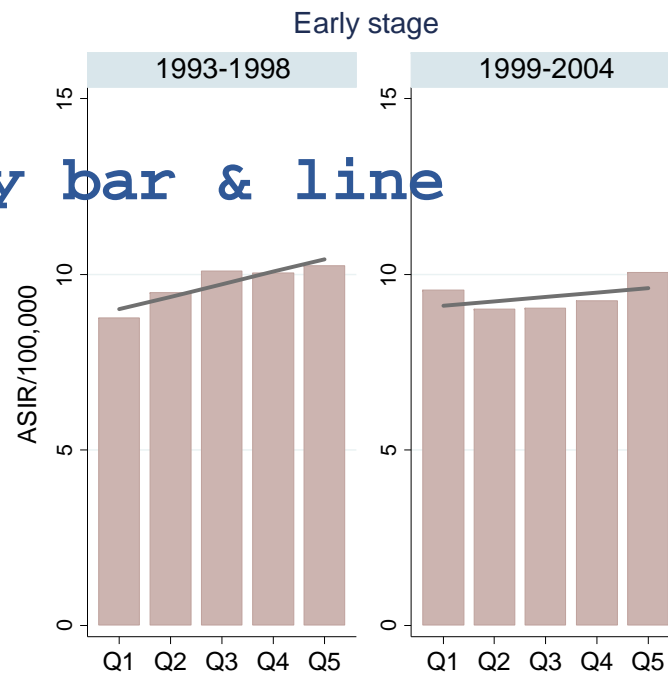
Stomach

Men



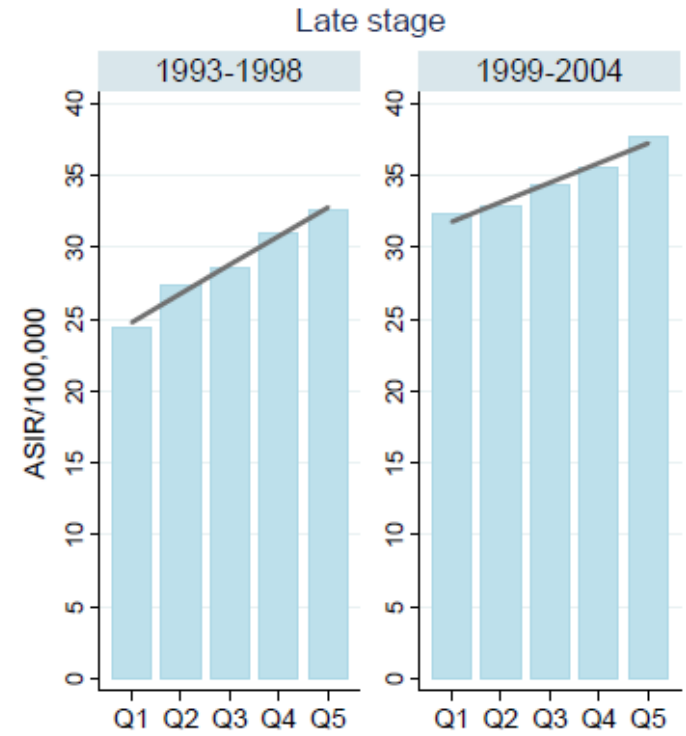
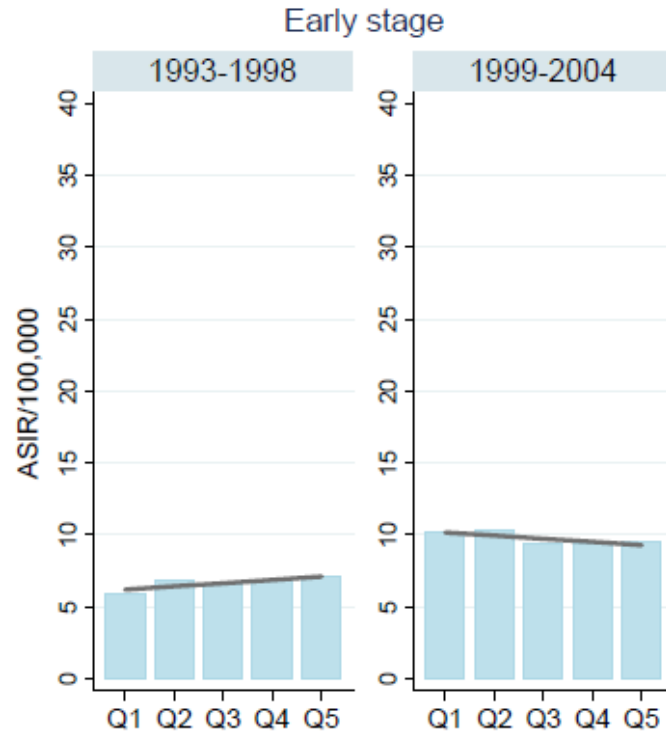
twoway bar & line

Women

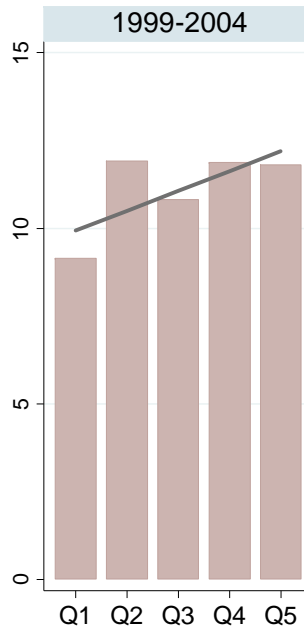
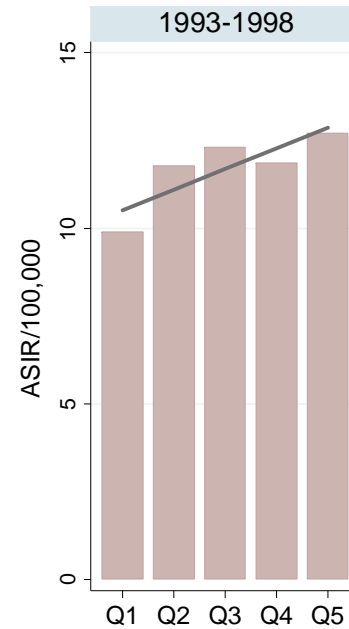
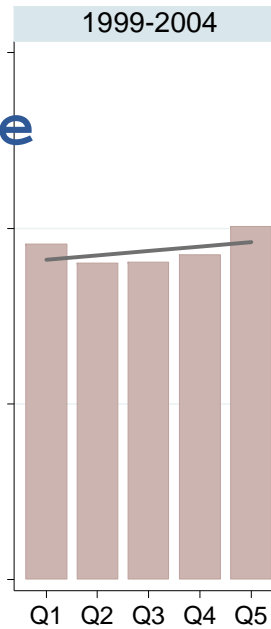
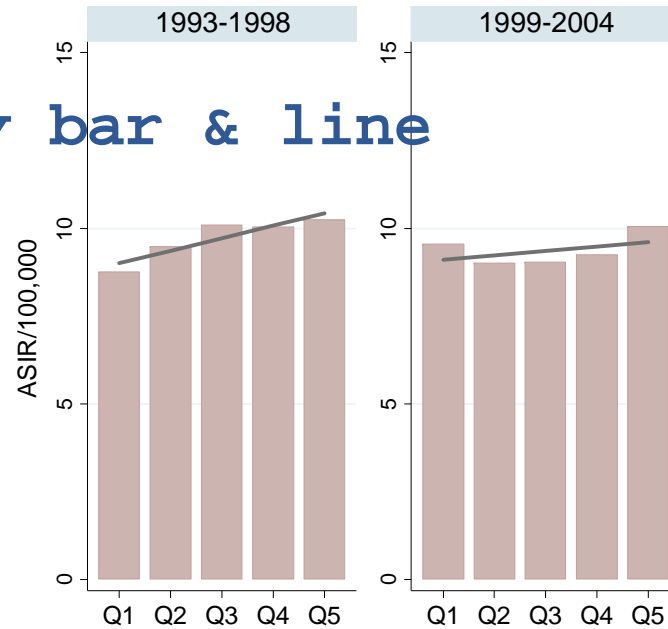


Lung

Men

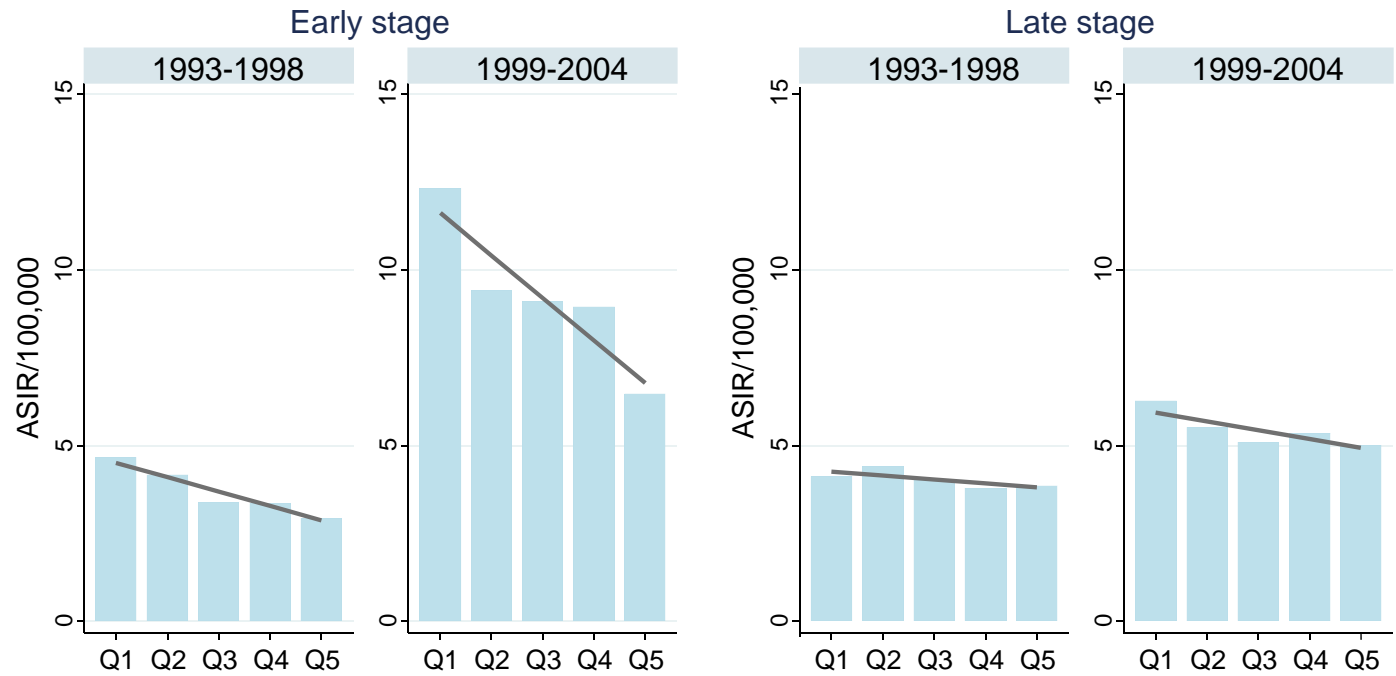


twoway bar & line

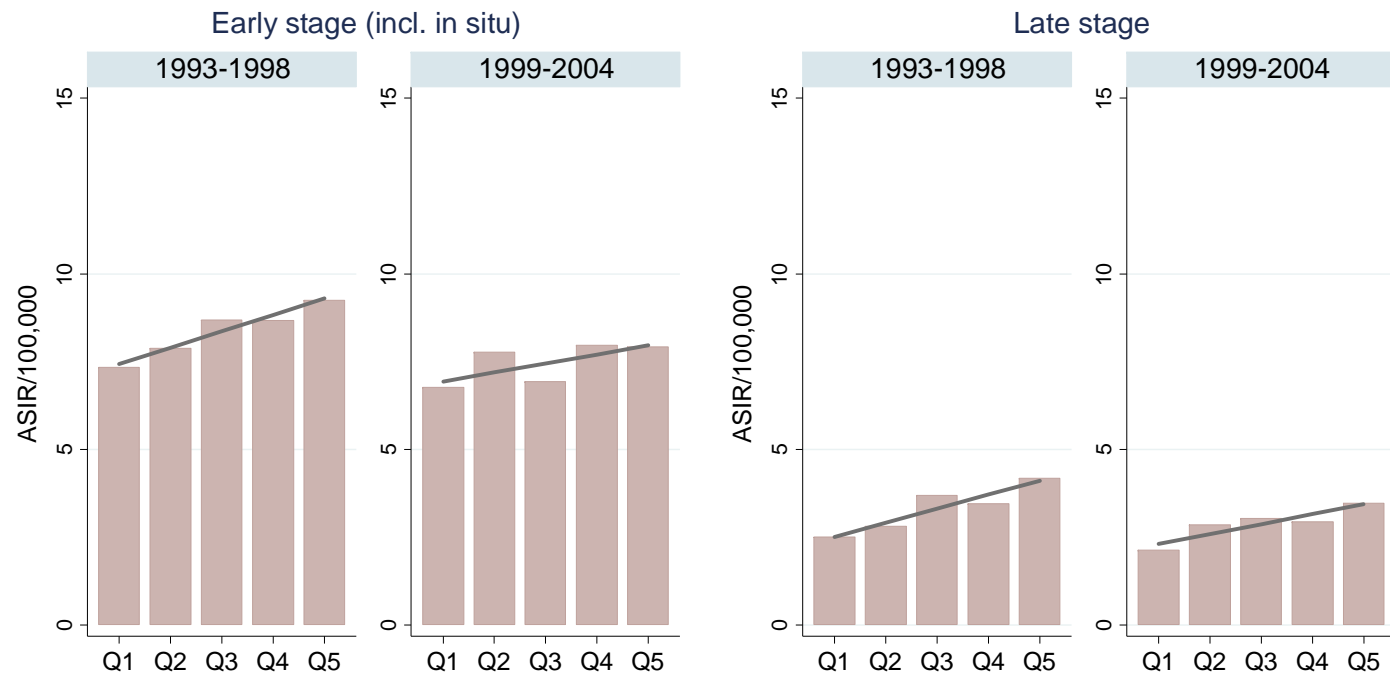


Women

Prostate

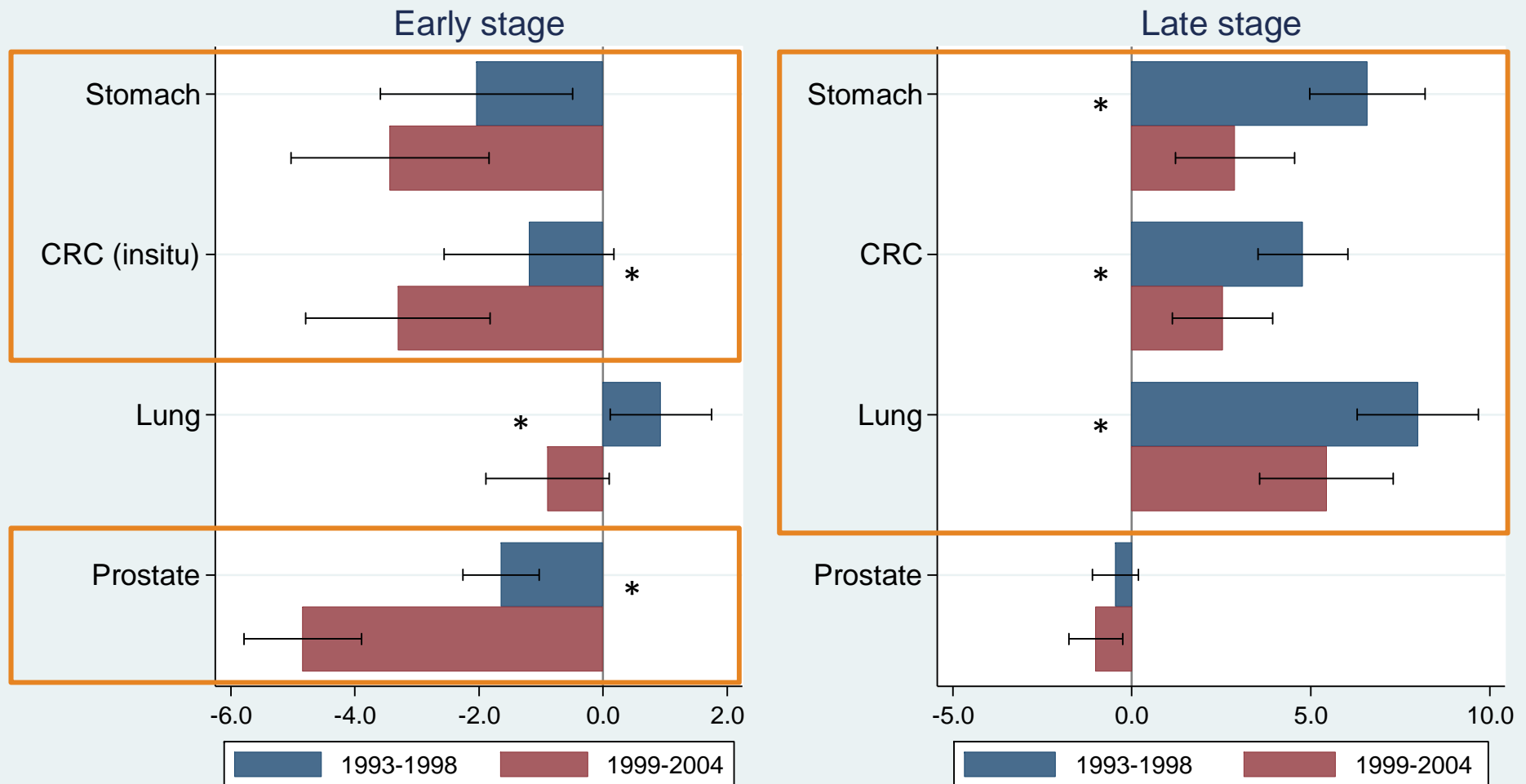


Cervix



Summary of deprivation gap: Men

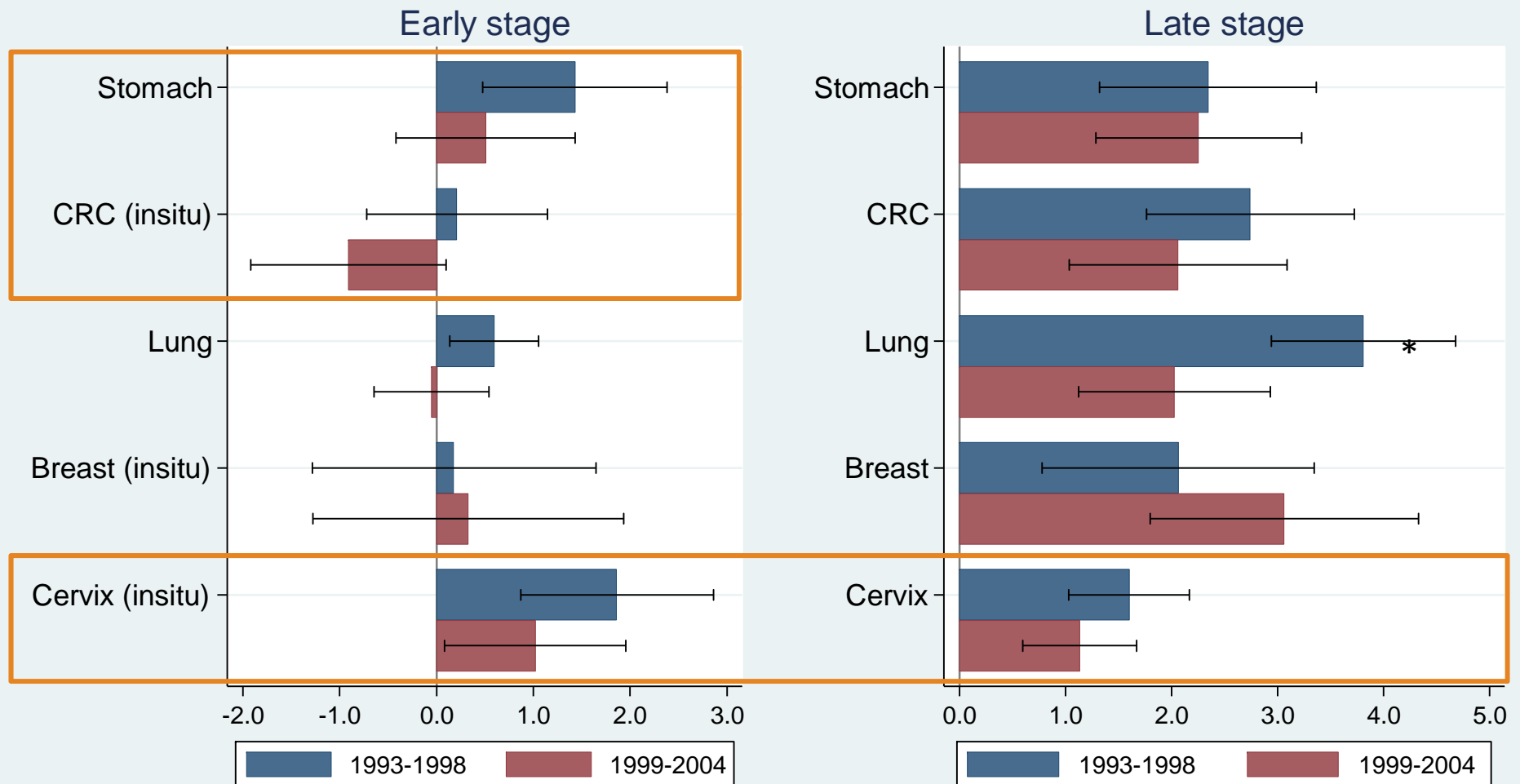
twoway bar & rcap



*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

Summary of results

- Late stage incidence
 - More deprived patients > less deprived patients, except for prostate cancer
 - Gaps became narrower
- Early stage incidence
 - Less deprived patients > more deprived patients, especially for male stomach, colorectal, prostate cancer
 - Gaps became wider during recent period
- Cervical cancer for both stages
 - 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

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政策科学総合研究事業（統計情報総合研究）
「健康格差対策に必要な公的統計のあり方に関する研究」班

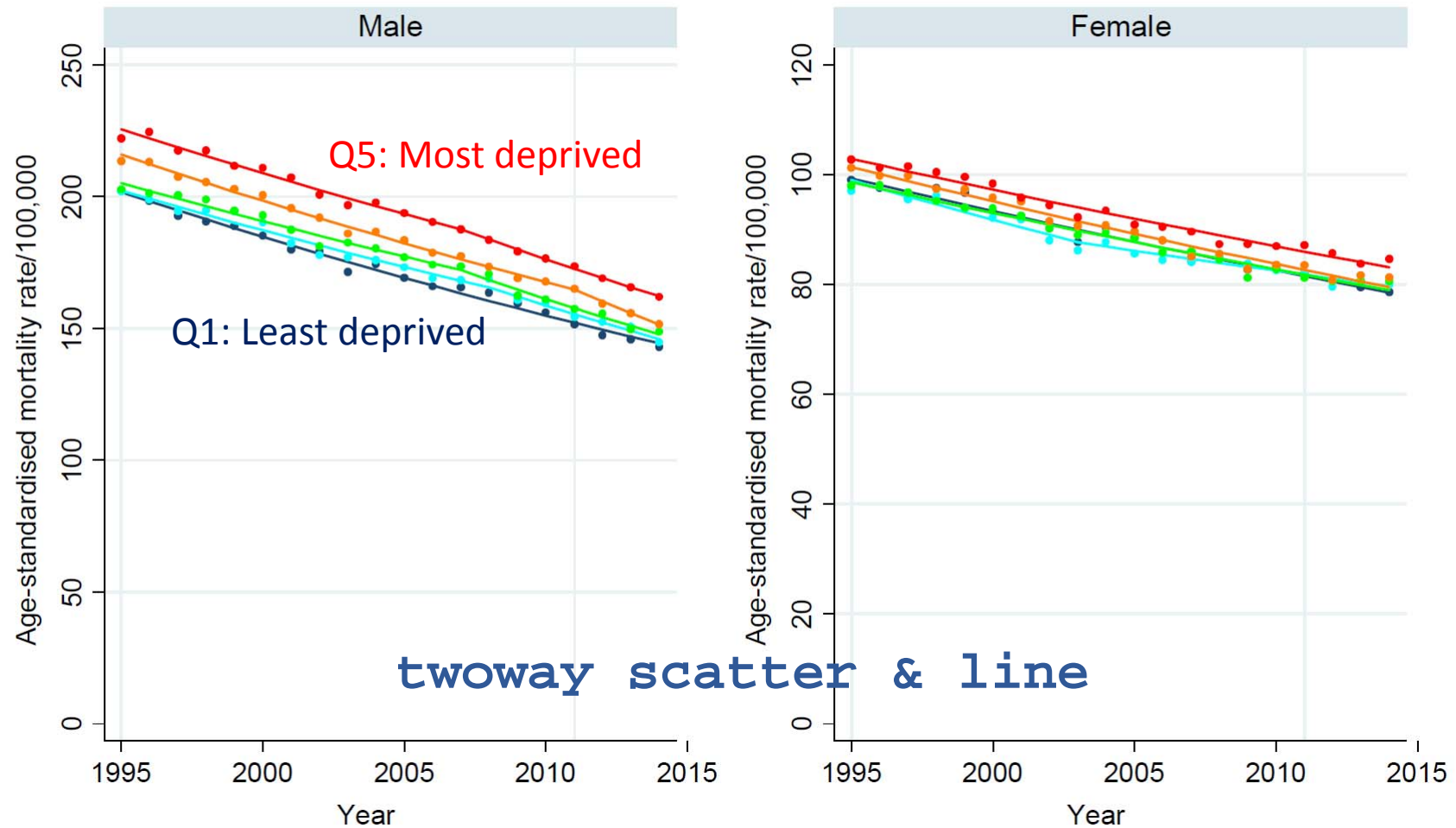
Data Sources

- 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):
 - Socio-economic status based on census-based information by municipality (Nakaya T. et al. PLoS One. 2014)

`merge 1:1 citycode`

Trends in all cancers by ADI quintile

Cancer: 0-84 years old
1995-2014



Statistical Analysis

1. Age-standardised mortality rate (ASMR) by quintile group of ADI `dstdize`
 - > 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

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

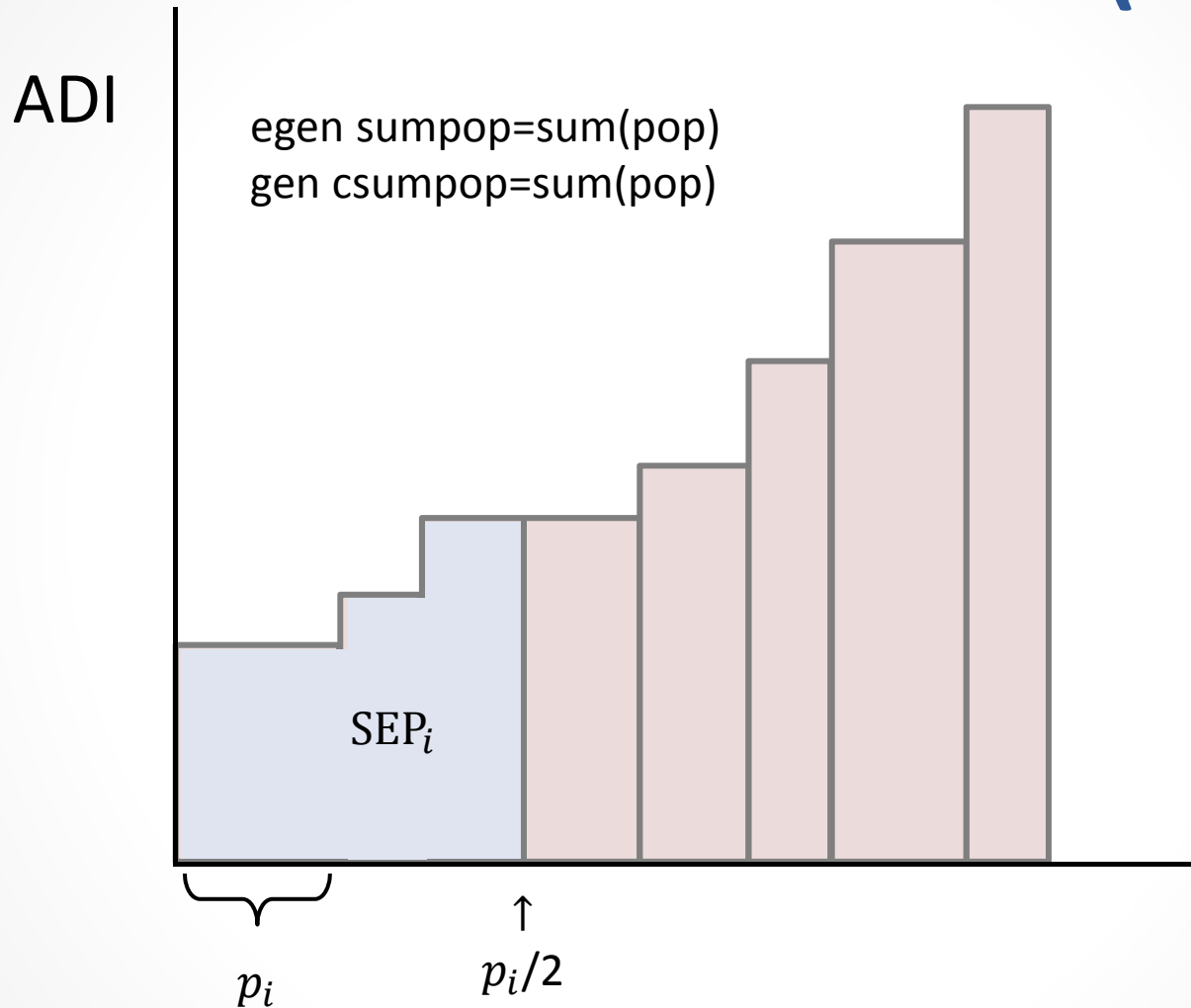
k: quintile

$$\log(\lambda_i) = \alpha + \sum_{k=2}^5 \beta_k \text{dep}_{ik}.$$

$$RR_k = \exp(\beta_k) \quad (k = 2, \dots, 5)$$

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

Socio-Economic Position (SEP)



i : municipality

p_i : proportion of municipality i

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)
```

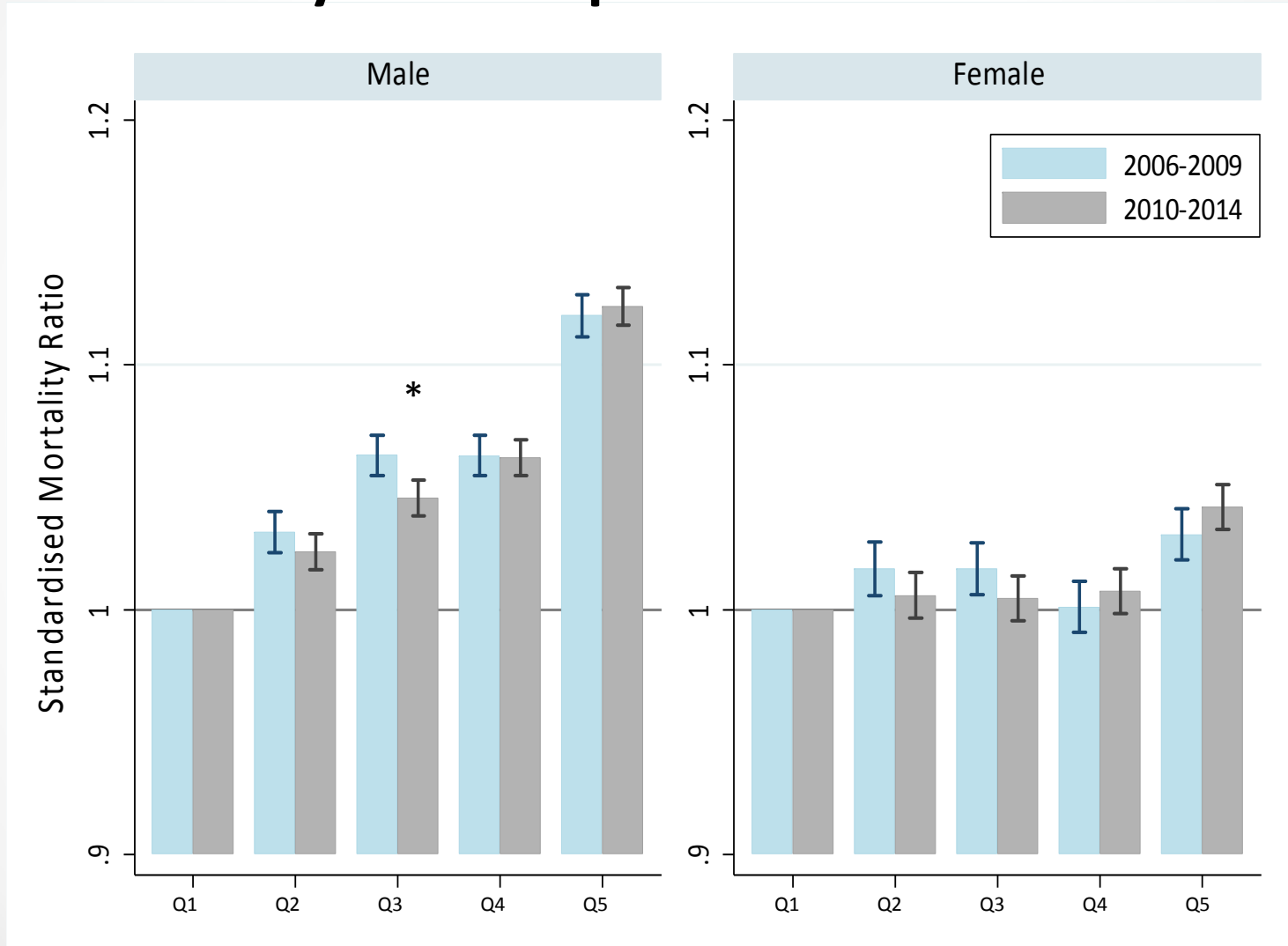
Statistical Analysis

4. Trends in RII using interaction term

$$\log(\lambda_{ij}) = \alpha + \beta \cdot SEP_i + \gamma \cdot period_j + \delta \cdot SEP_i \cdot period_j$$

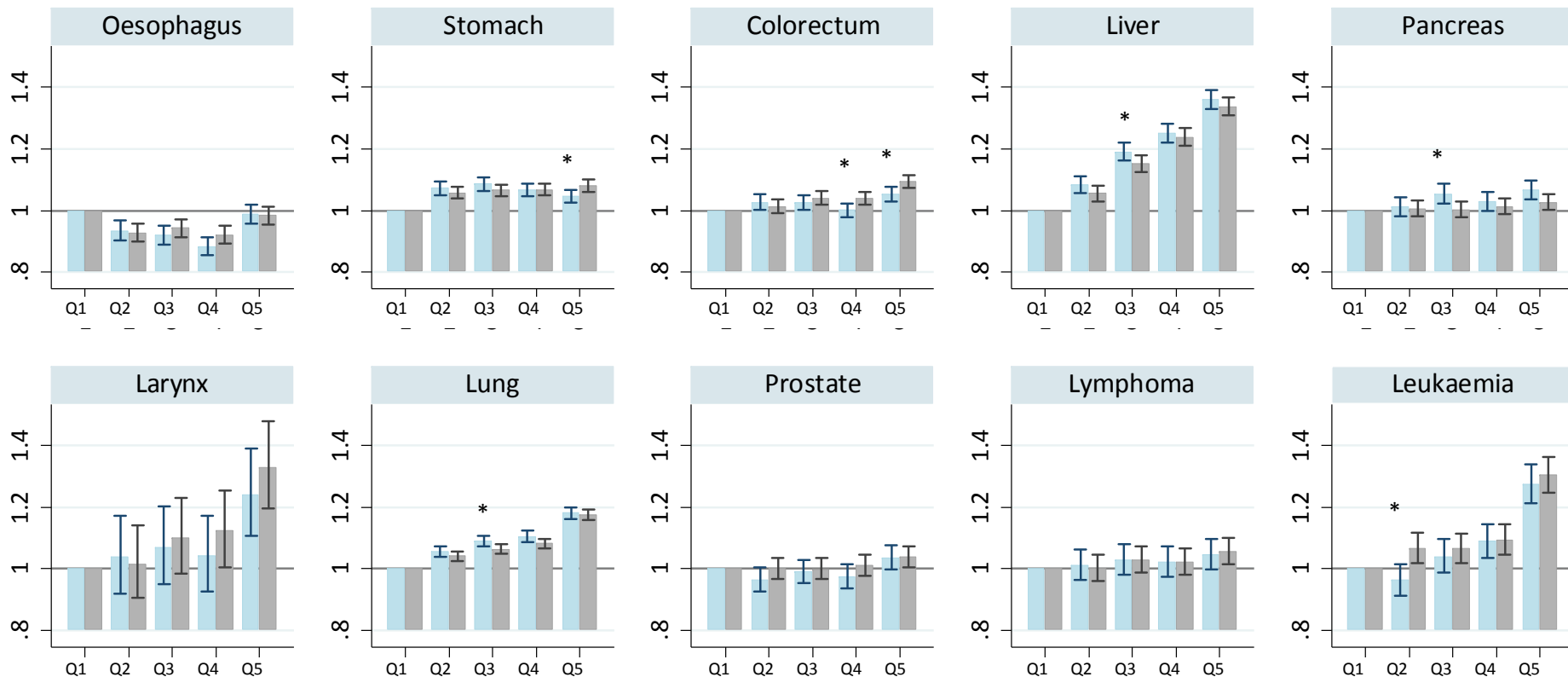
```
glm obs sepi i.cnyear i.cnyear##c.sepi  
if sex==`g', family(poisson) link(log)  
offset(lnexp) eform
```

Standardised Mortality Ratios (SMRs) of All sites of cancer death by ADI in Japan in 2006-2014



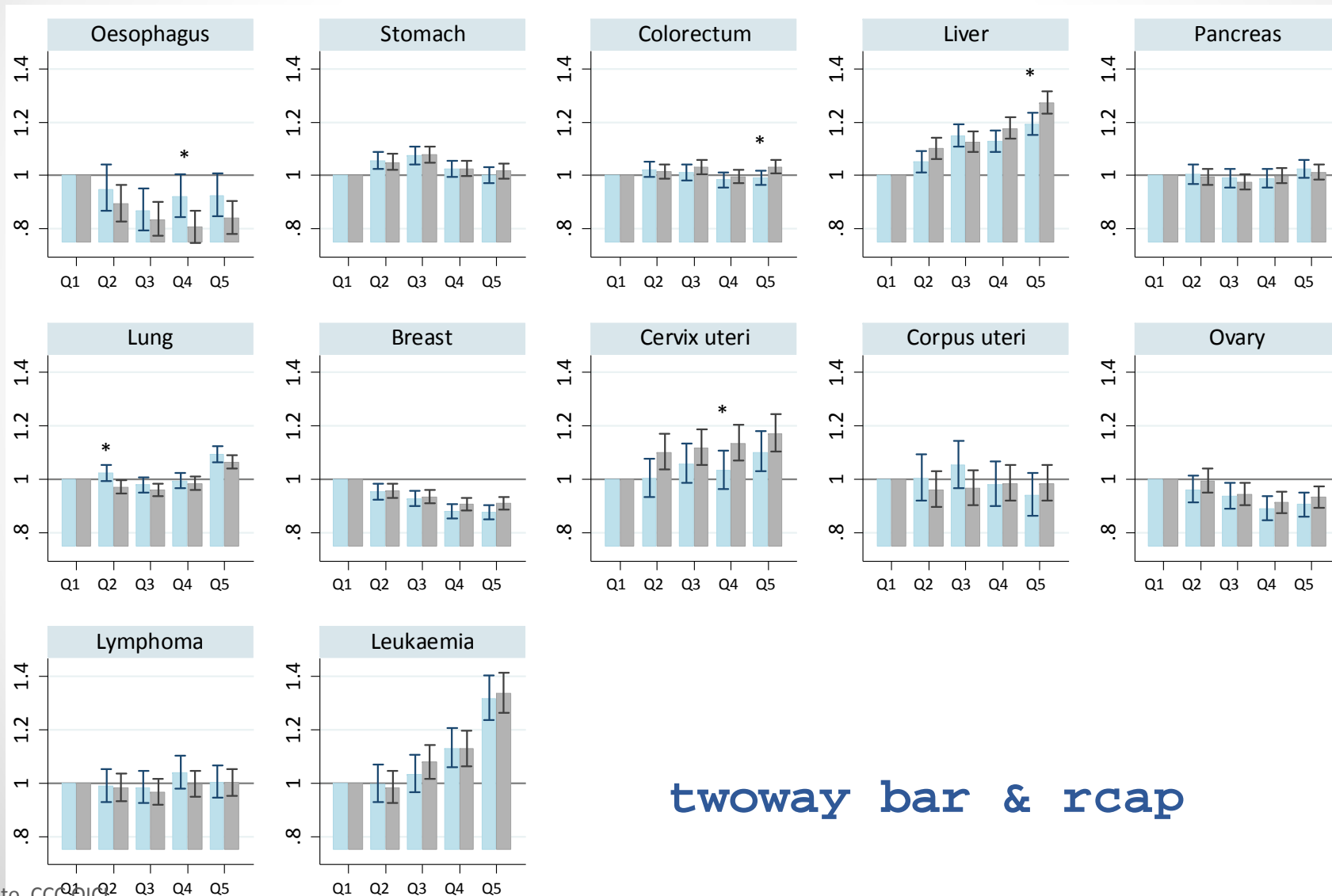
● * $p < 0.05$ for interaction between ADI and period

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



twoway bar & rcap

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



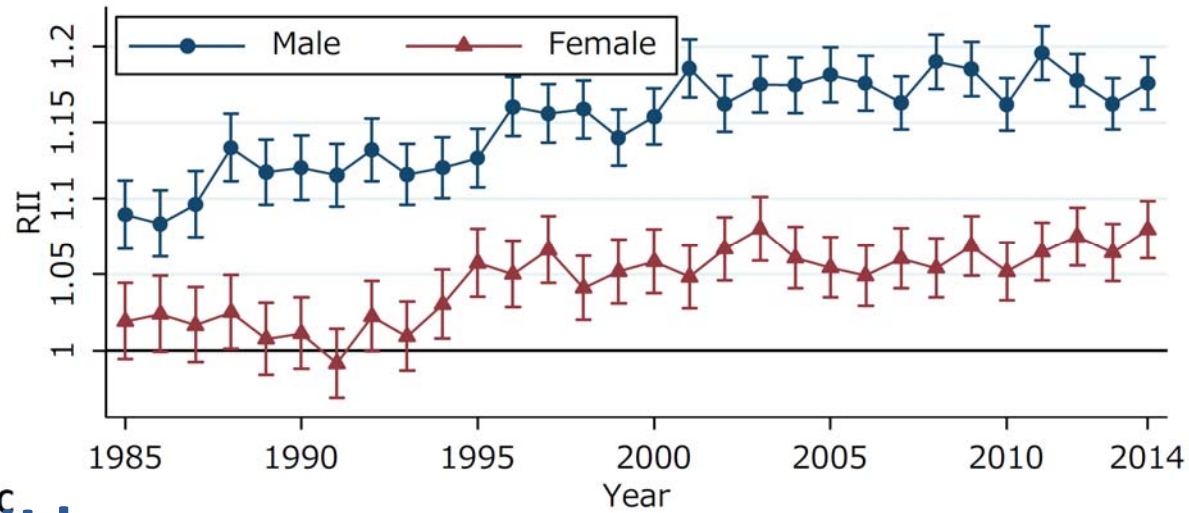
twoway bar & rcap

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
 - Liver: Less access to treatment for Hepatitis virus C
 - Lung: Higher smoking rate in the more deprived group
 - Cervix: Lower attendance rate of cancer screening
 - Leukaemia: Regional effect? (e.g. High incidence in the west part of Japan), Expensive and long-term treatment? (e.g. Bone-marrow transplant)
- Inverse contrast was observed in Breast, Corpus uteri and Ovarian cancer
 - Related to the high risk lifestyle in the less deprived group? (reproductive factor, alcohol consumption)

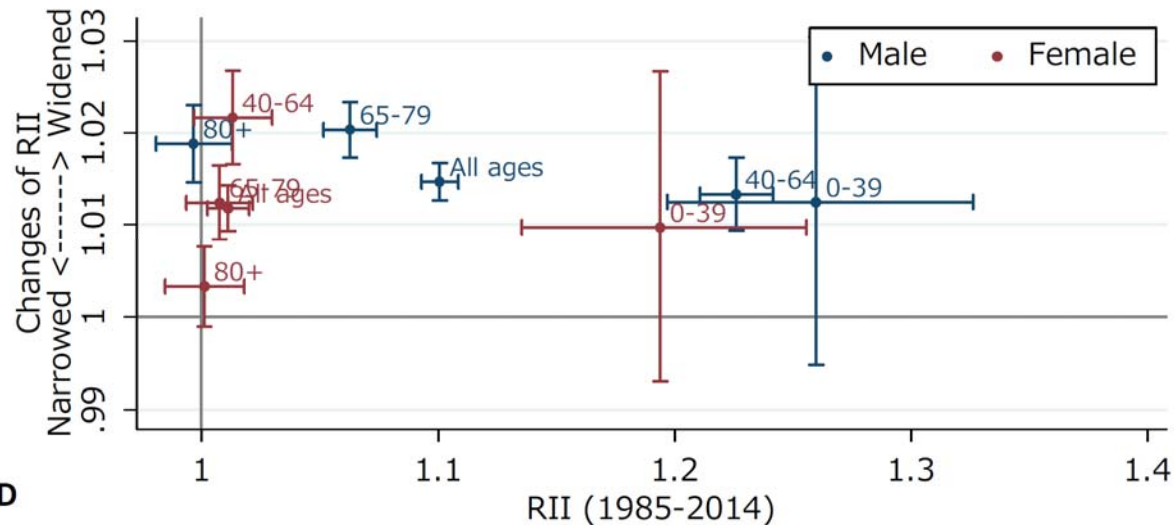
Long-term trends in Relative Index of Inequalities (RII)

Cancer



Trends in RII by age group

twoway scatter & rcap



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

Causal mediation analysis
Gformula, paramed,...



Model simulation

- Take measures to reduce the gap

Thank you for your attention!



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

itou-yu2@mc.pref.osaka.jp