# Understanding the Effects of Early Malnutrition: The Dutch Hunger Winter

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Netherlands Interdisciplinary Demographic Institute (NIDI-KNAW/RUG)

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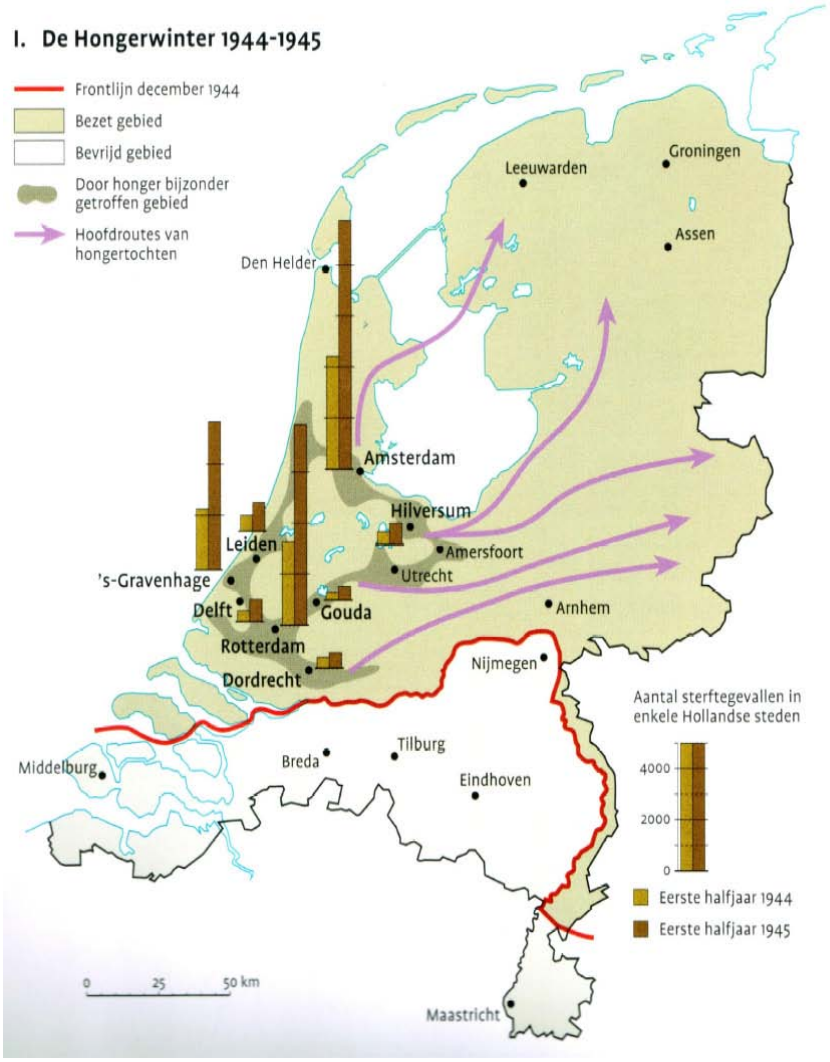
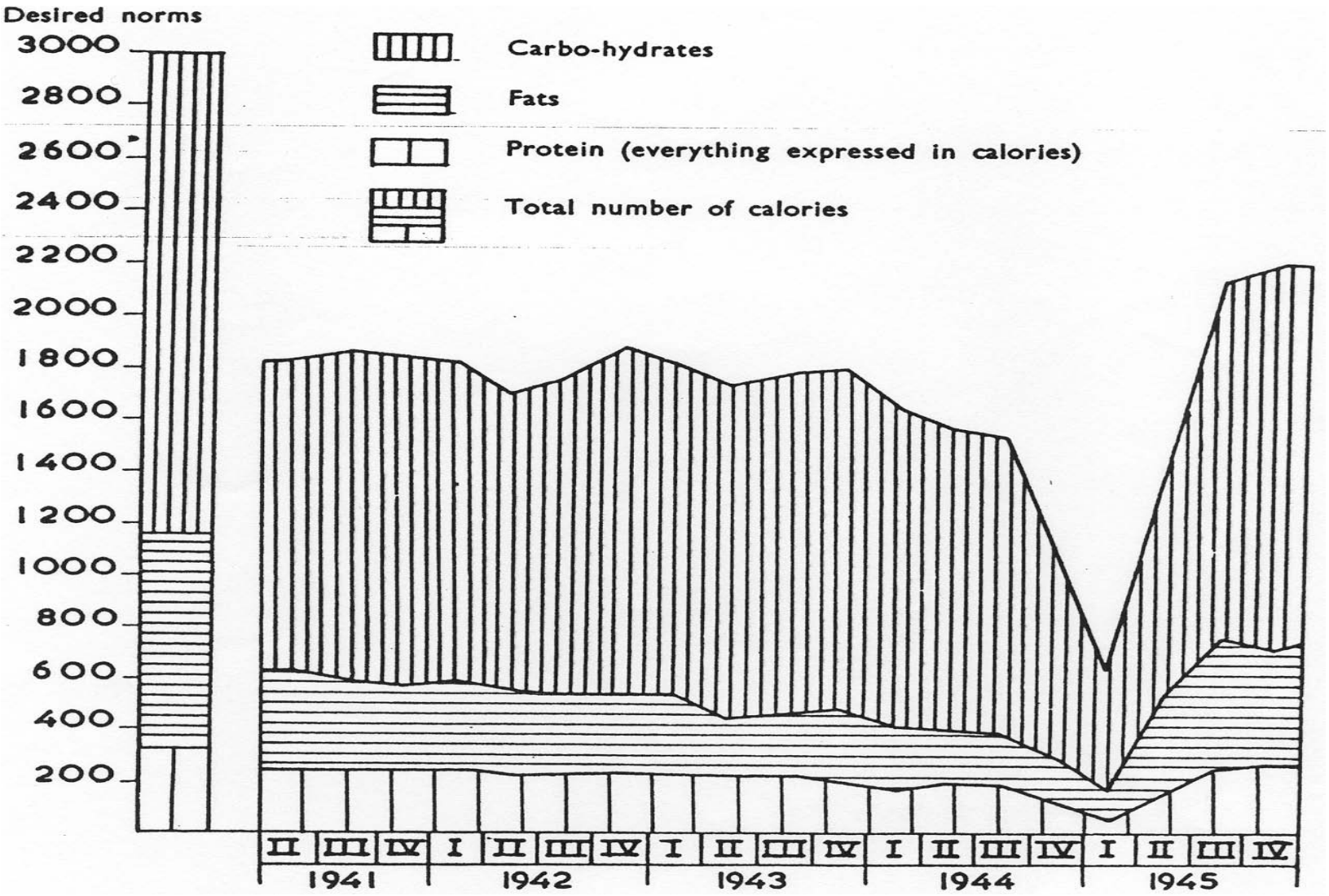
# Dutch Hunger Winter, 1944-1945




- Transport embargo
  - German response to rail strike in support of advancing Allied troops.
  - Rail strike was continued by Dutch for non-military reasons after failed military advance
- Limited to western Netherlands
- Ended with surrender of the German forces, May 1945

# Food rations, (Burger et al. 1948)



# Dutch Hunger winter 1944-1945

Opportunity to identify effect of early life circumstances on later life outcomes

- Famine struck unexpectedly (natural experiment) affected population had major problems obtaining food elsewhere;
- Well defined in time (7 months) and space (cities in the West);
- Population was ethnically homogeneous without prior differences in dietary patterns;
- Long-term follow up is possible

# Motivation

Long lasting effects of Malnutrition during childhood:

- Fetal origin hypothesis
  fetal conditions are persistent, adapting to food scarcity leads to survival advantage under the adverse situation
  increased mortality and worse health later in life

- Selection hypothesis: culling vs scarring
  Only the strongest, healthiest, survive or negative selection

## Early life circumstances influences later life health and mortality

- Inadequate nutrition in utero increase the risk of cardiovascular mortality (Barker 2006; Cameron and Demerath 2002)
- In utero famine leads to cardiovascular disease, hypertension, type II diabetes, higher mortality, or obesity (Barker et al. 1990; Gluckman et al. 2008; Schulz 2010))
- In utero exposure to 1918 pandemic had negative effect on self-reported health (Almond and Mazumder 2005).

See also Lumey et al. 2011, Almond and Currie 2011 or Pollitt et al. 2005.

# Early life influences later life socio-economic outcomes

- In utero exposure to 1918 pandemic led to low educational and job-market outcomes ((Almond 2006; Mazumder et al. 2009))
- Chinese 1959-1961 Famine had adverse labour market effects (Chen and Zhou 2007)
- Early life exposure to the Greek Famine 1941-1942 impairs the development of human capital (Neelsen and Stratmann 2011)
- Exposure to Dutch Famine during $1^{\text{st}}$ trimester leads to lower employment (Scholte et al. 2015)

# Military recruits Data, men born 1944-1947

Examinations for military service 1961-1965

- Detailed info on individual demographic and socioeconomic characteristics, including father's occupation, religion, birth order, and place of birth
- Mental performance and Battery of intelligence tests: Raven progressive matrix, Arithmetic test, Language test, Bennett, Clerical Aptitude
- Health indicators: Height, BMI, chest, fit for service, conditions diagnosed at examination
- Education attained (at age 18)

# Linkage to administrative records from CBS

- Mortality and Cause of death (up till Dec 2013)
- Socio-economic status (1999-2013) on monthly basis
  main source of income: (un)employment, retirement, disability
- Annual personal income (2003-2013)
- Residential and non-residential care use (2004-2013)
- *Planned*:
  Medication use, Insured costs covered by health insurance.

# Does the famine has Impact on measures at age 18?

- BMI, obesity (BMI $\geq 30$) or overweight (BMI $\geq 25$)
  (Ravelli et al, New England J Medicine 1976)
- Height
- Intelligence, Raven matrix
  (Stein et al, Science 1972)
- Education attained

# Ravelli 1976, Famine birth cohorts

A1 Born Jan 1944- May 1944: Exposure after 6 months

A2 Born Jun 1944- Oct 1944: Exposure 1 to 10 months

B1 Born Nov 1944- Jan 1945: Exposure 3$^{\text{rd}}$ trimester + post natal

B2 Born Feb 1945- May 1945: Exposure 2$^{\text{nd}}$ trimester

D1 Born Jun 1945- Sep 1945: Exposure 1$^{\text{st}}$ trimester

D2 Born Oct 1945- Dec 1945: Exposure conception

E1 Born Jan 1946- Jun 1946:

E'1 Born Jul 1946- Dec 1946:

E2 Born Jan 1947- Jun 1947:

E'2 Born Jul 1947- Dec 1947:

# Obesity, (Ravelli et al, 1976)

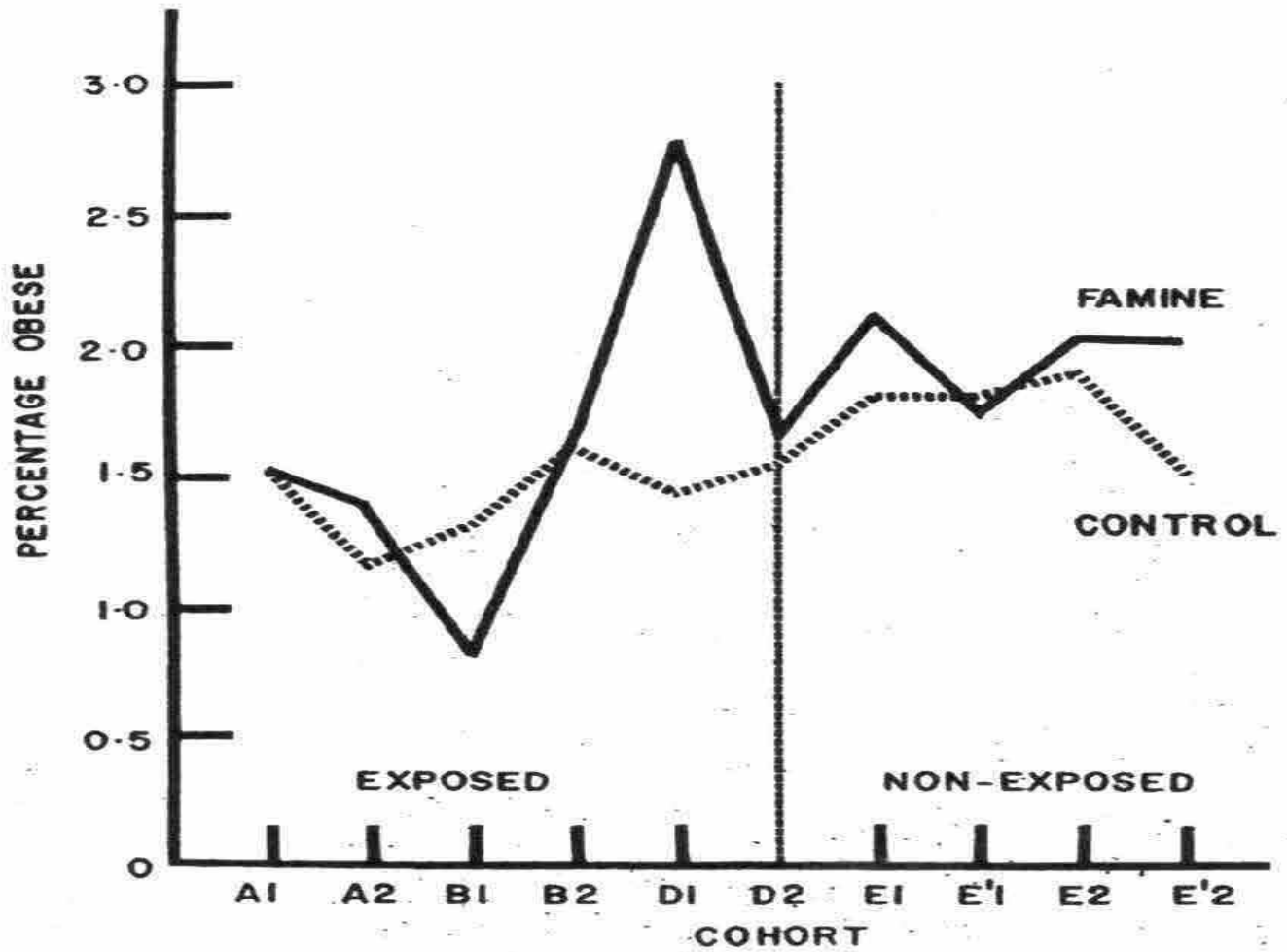
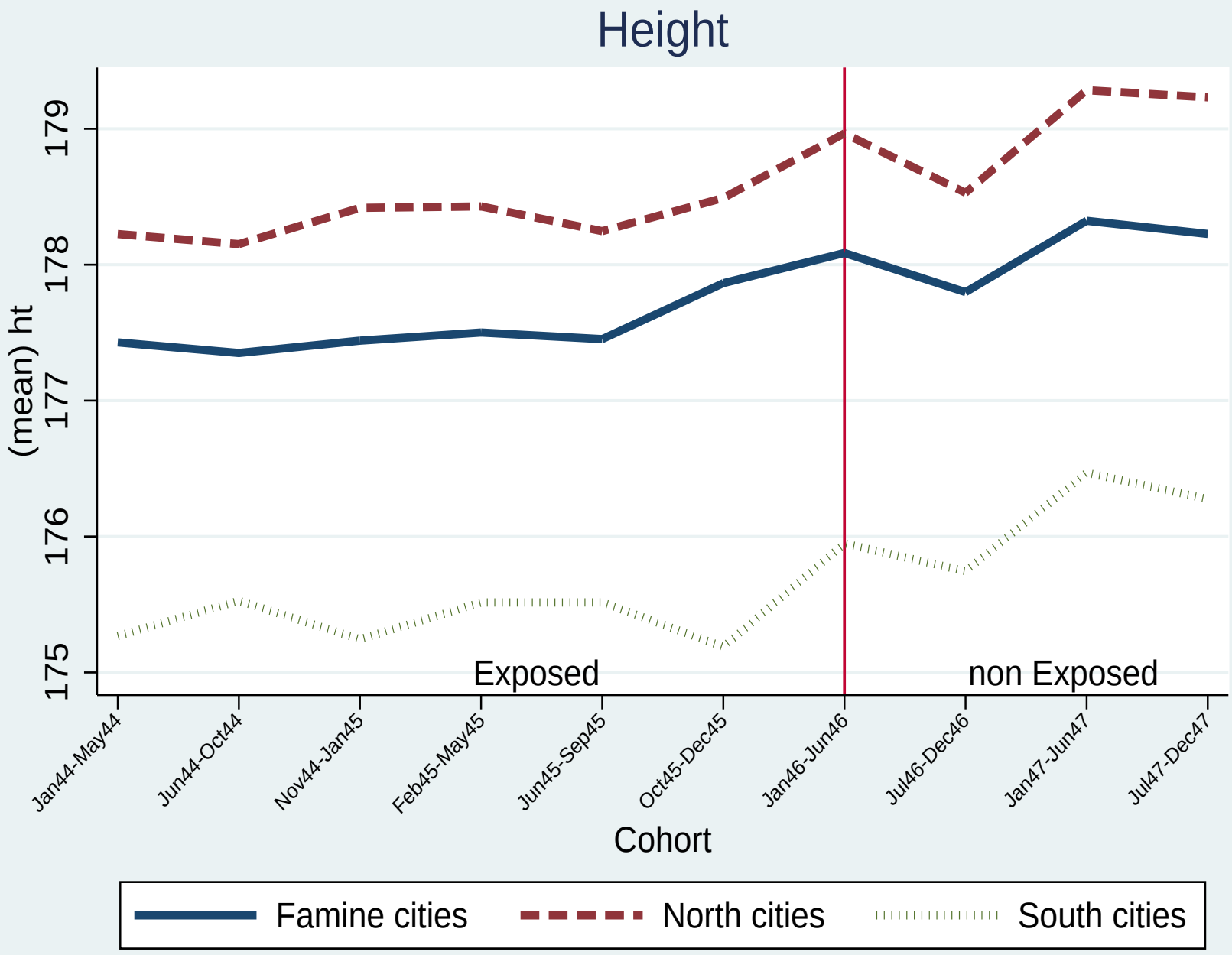
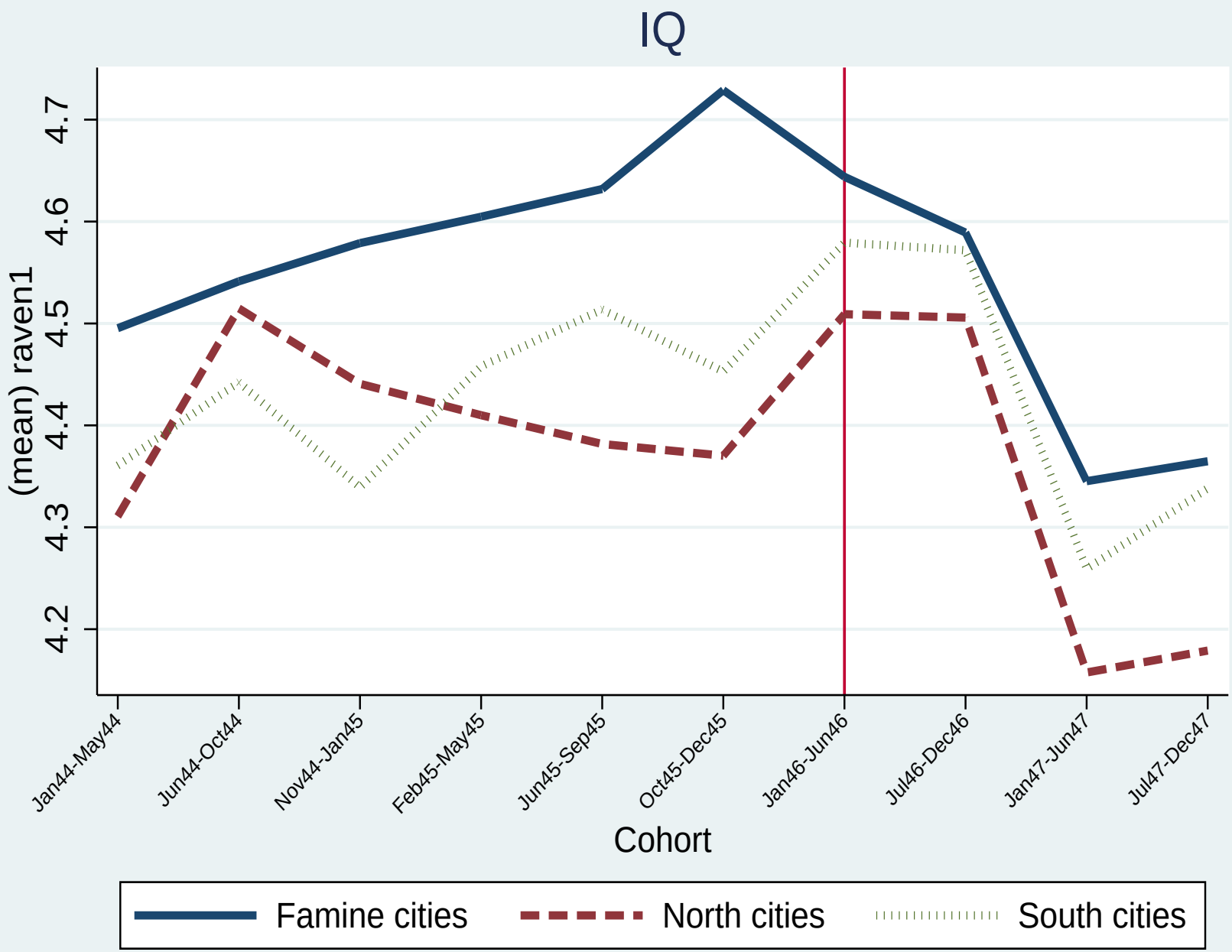



Figure 2. Obesity Prevalence Rates among Birth Cohorts in Famine and Control Areas.

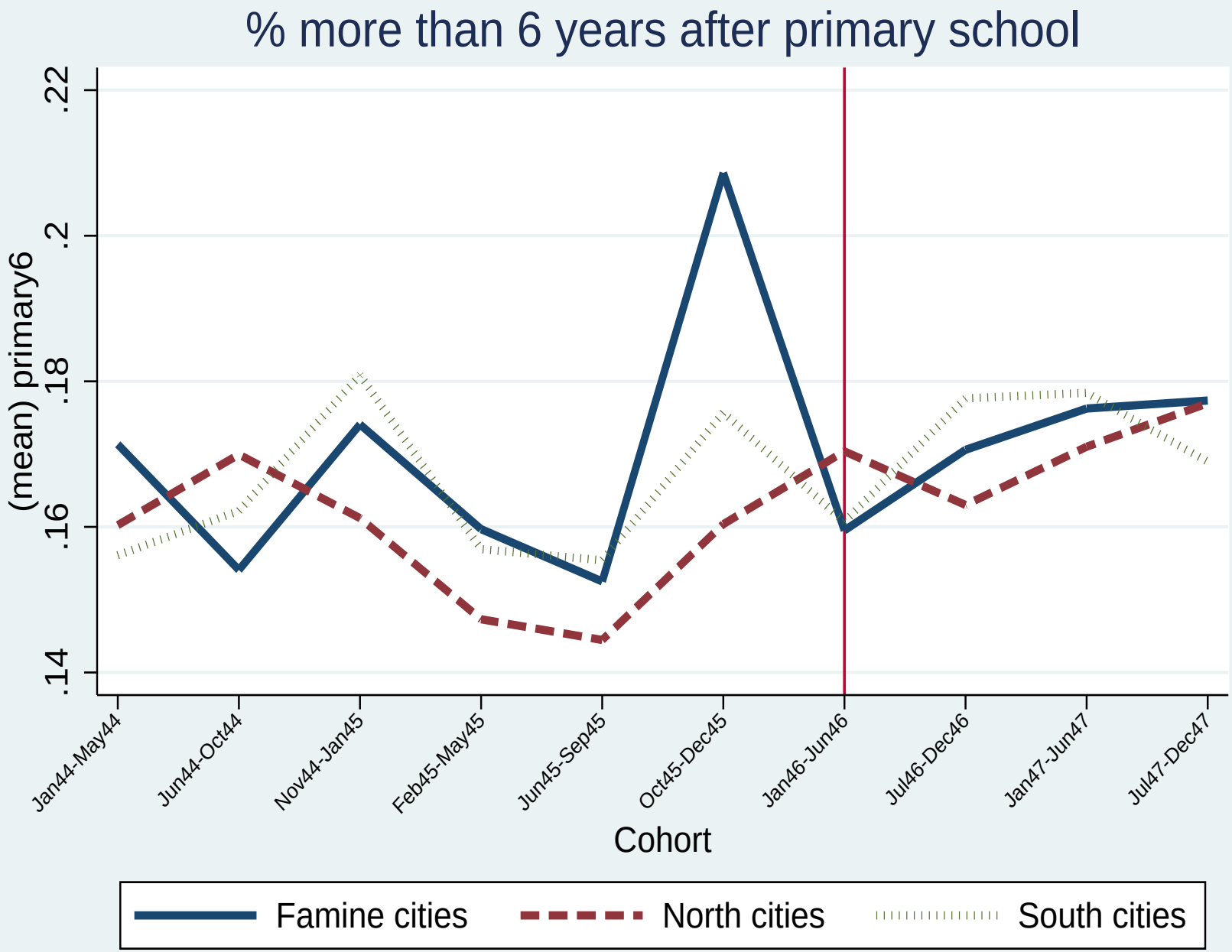
# Height


Height
(mean) ht
175
176
177
178
179
Exposed
non Exposed
Jan44-May44
Jun44-Oct44
Nov44-Jan45
Feb45-May45
Jun45-Sep45
Oct45-Dec45
Jan46-Jun46
Jul46-Dec46
Jan47-Jun47
Jul47-Dec47
Cohort
Famine cities
North cities
South cities

# Intelligence, Raven



# Education attained at age 18

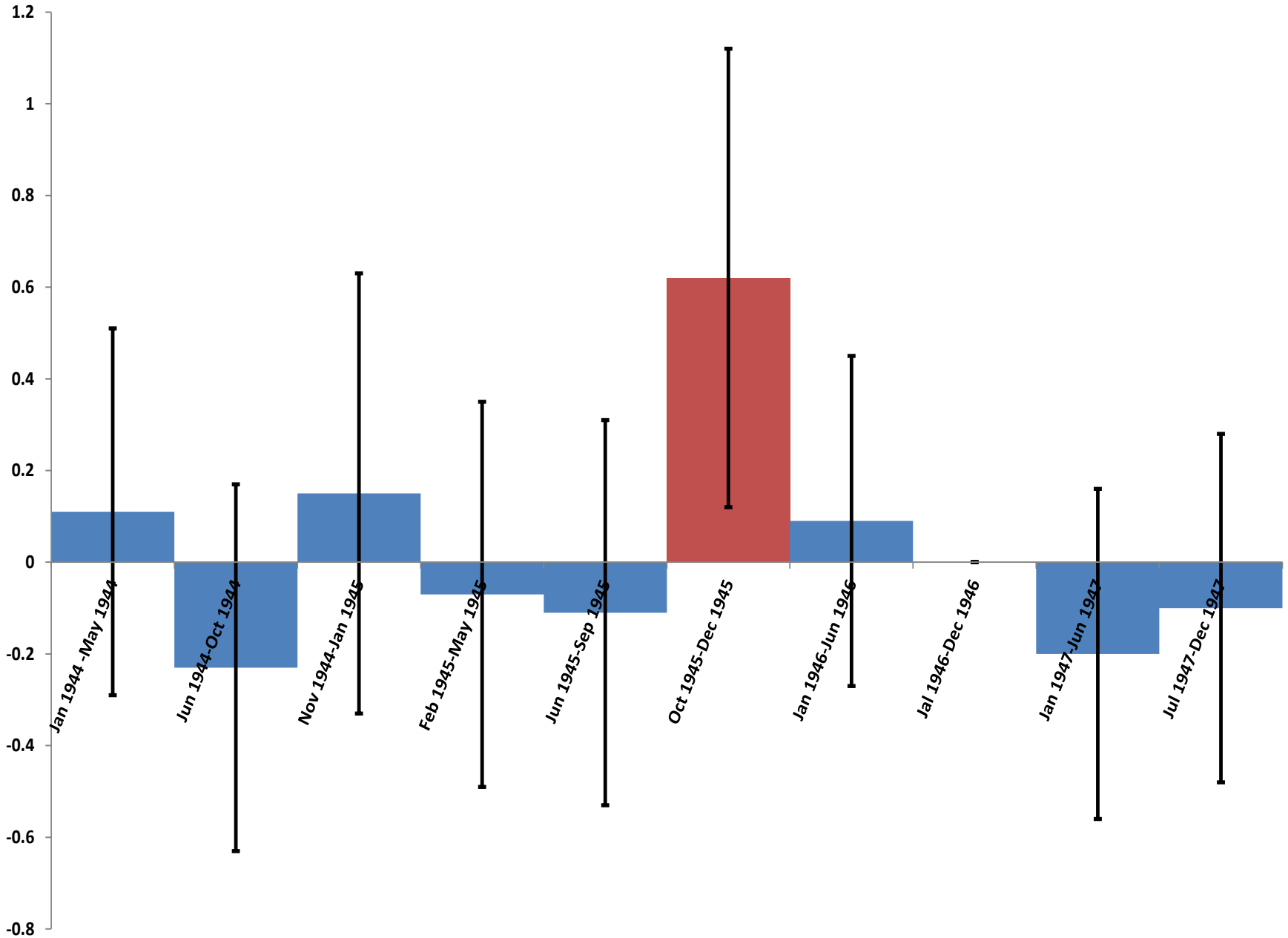


# Accounting for trends and background

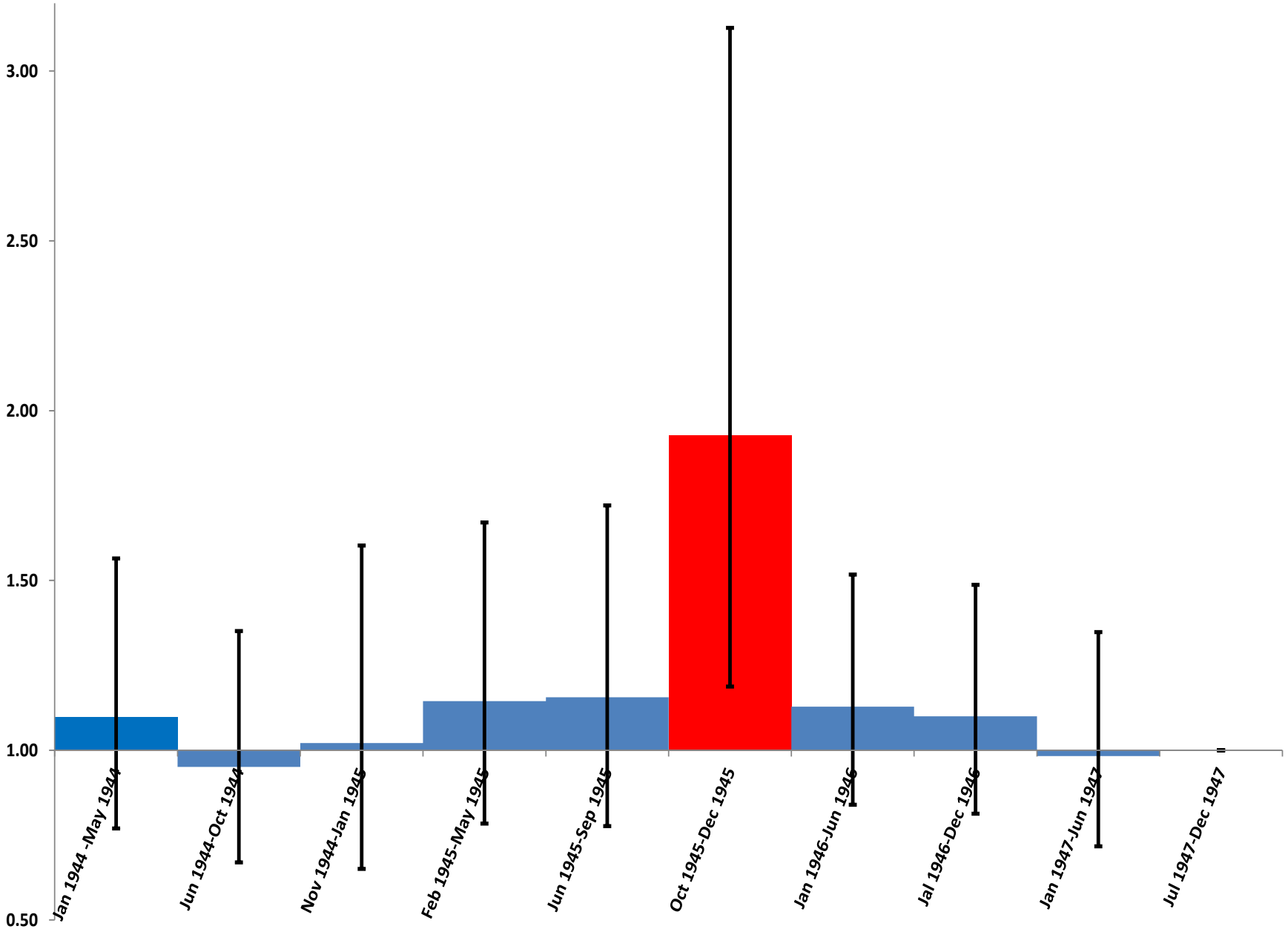
**Difference-in-difference analysis**

- Assuming that famine region (cities) and other regions are subject to same time trend
  e.g. apart from famine height growth the same in all regions
- Average change (difference-in-difference) compared to reference period (we choose Jan 1946-Jun 1946) to obtain famine effect in each famine period
- This removes impact of difference among regions that affect outcome

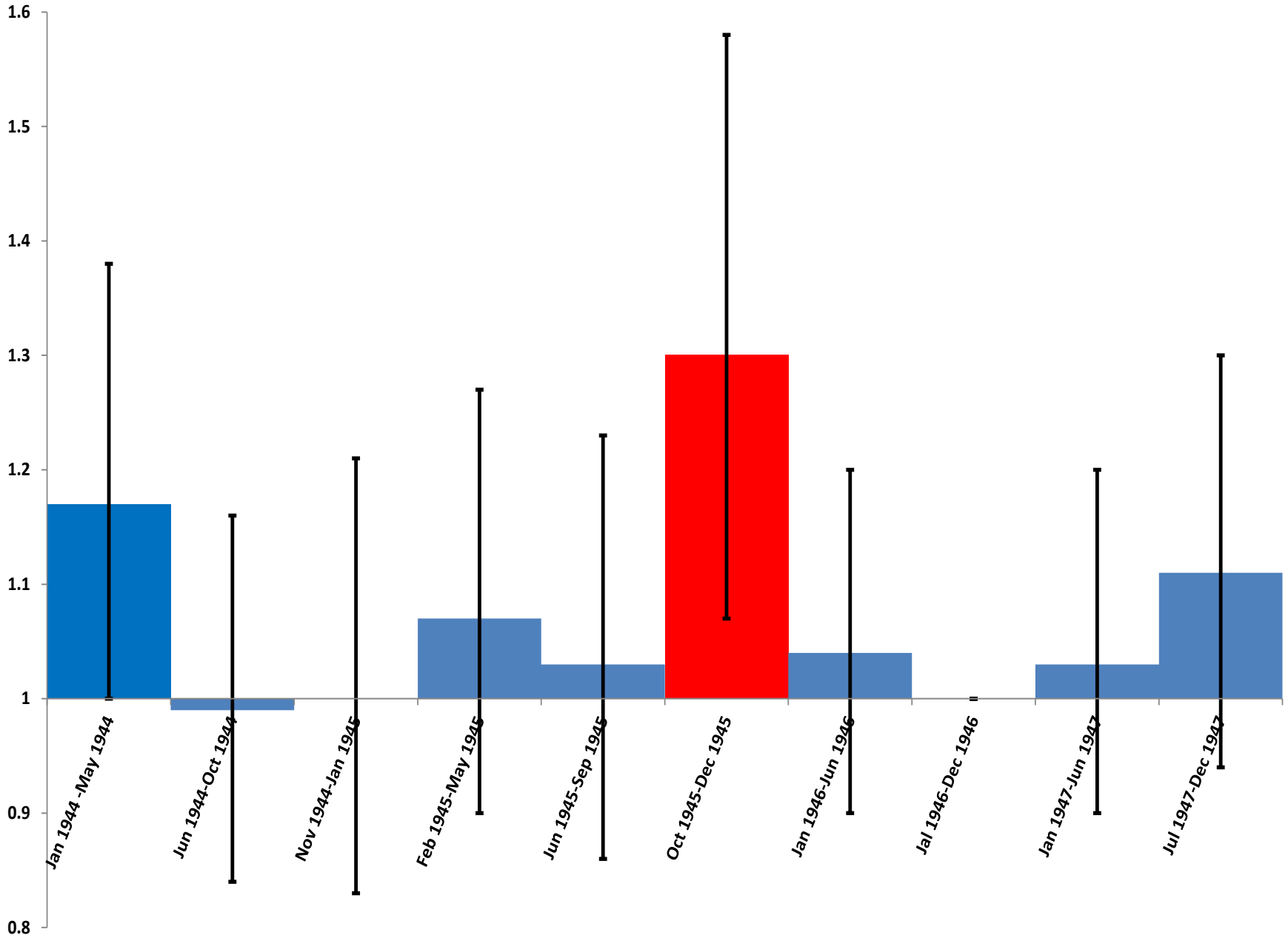
# Effect Famine on height



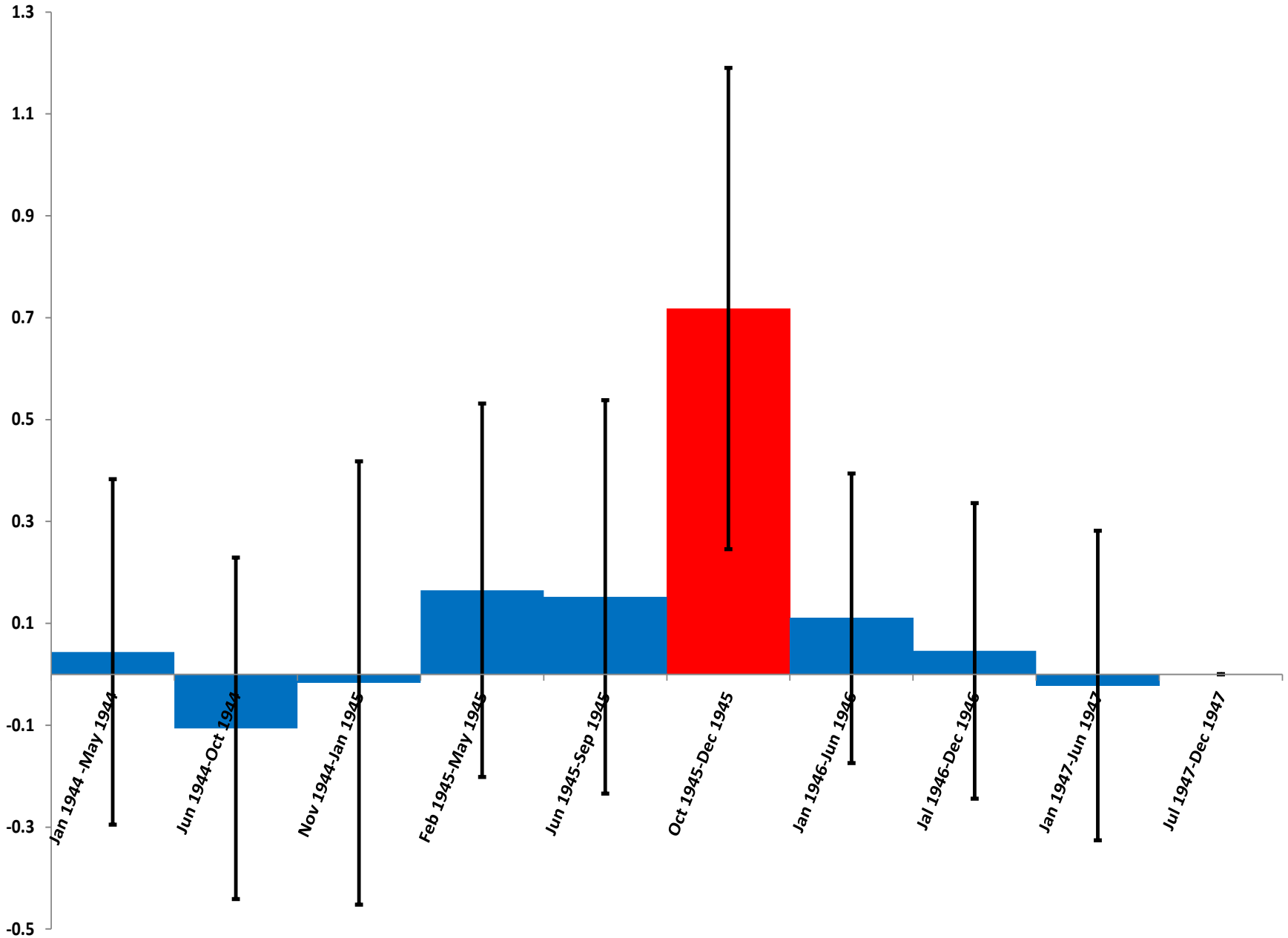
# Effect Famine on overweight, odds ratio



# Effect Famine on probability of > years education, odds



# Effect Famine on IQ (Raven)



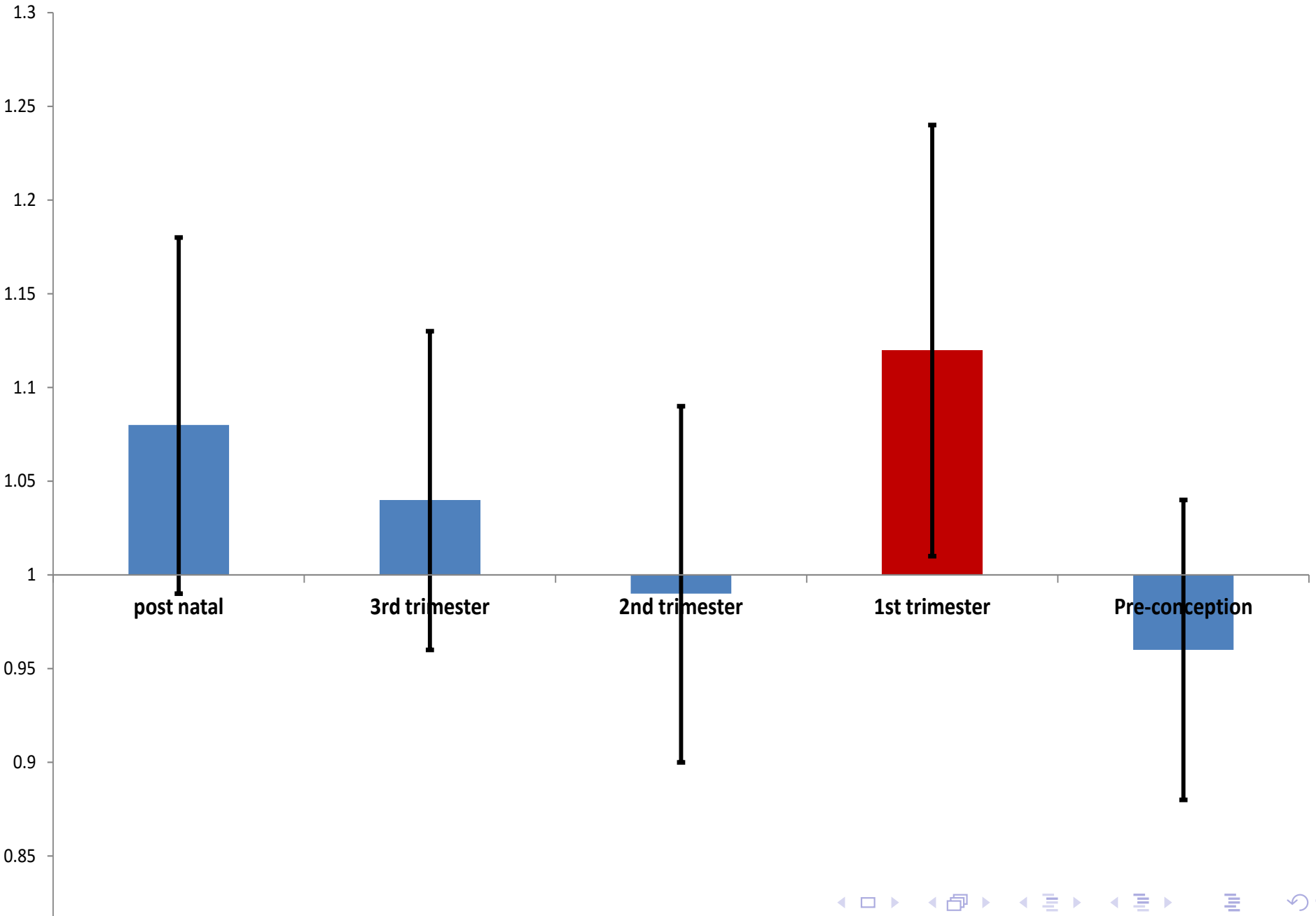
# Does the famine has influence mortality?

- All cause mortality
  (Ekamper et al., Social Science & Medicine 2014)
- Cause specific mortality
  (Ekamper et al., American J o Epidemiology 2015)

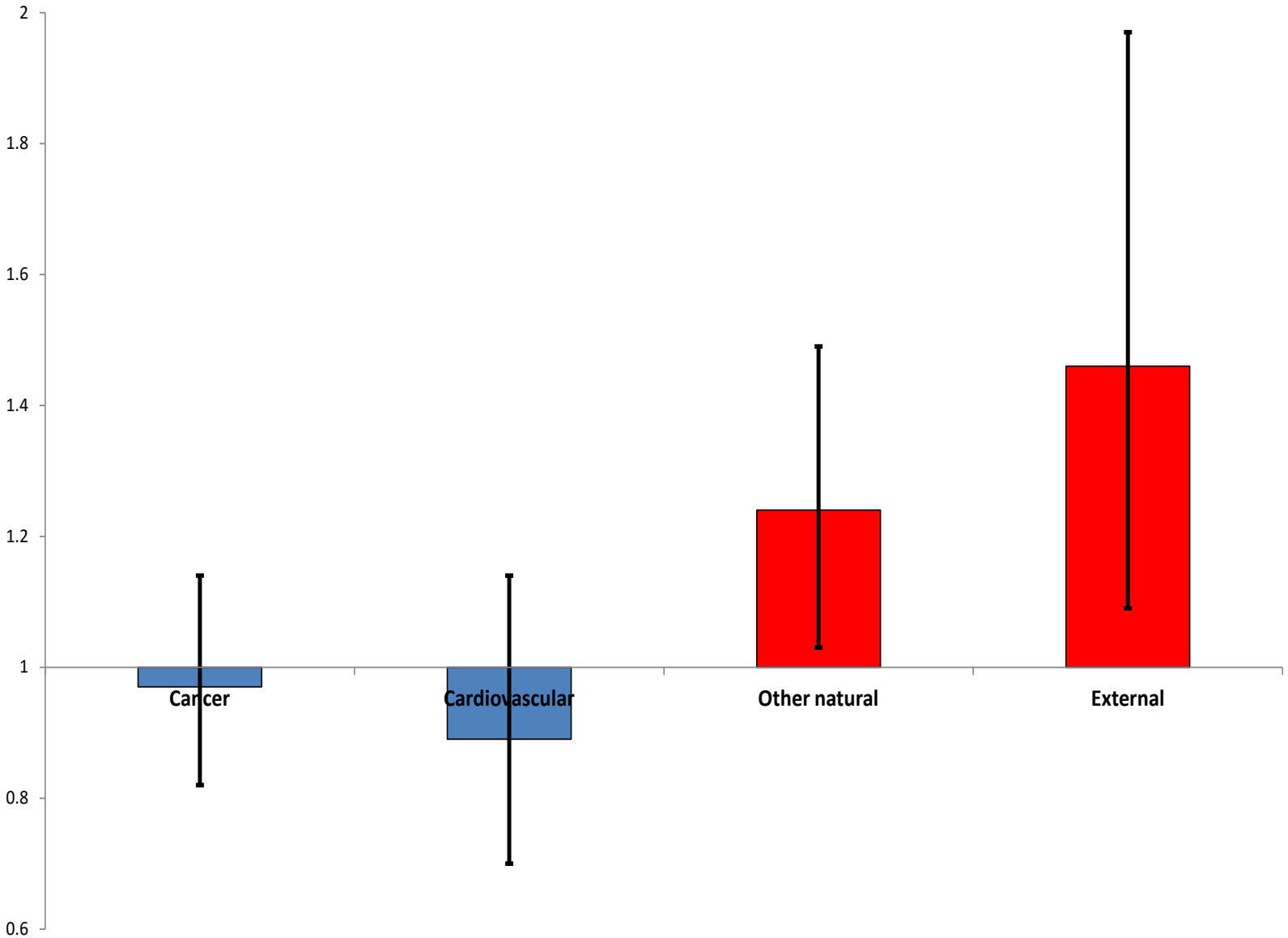
Overlapping cohorts:

- Post-natal: born Nov 1944- May 1945;
- $3^{\text{rd}}$ trimester: born Feb 1945 - May 1945
- $2^{\text{nd}}$ trimester: born Apr 1945 - Aug 1945
- $1^{\text{st}}$ trimester: born Jul 1945 - Dec 1945
- Pre-conception: born Nov 1945- Nov 1946;

# Effect famine on mortality, (Ekamper et al., 2014)



# Effect famine on Cause specific mortality, (Ekamper et al., 2015)



# Does the famine has long-run socio-economic impact?

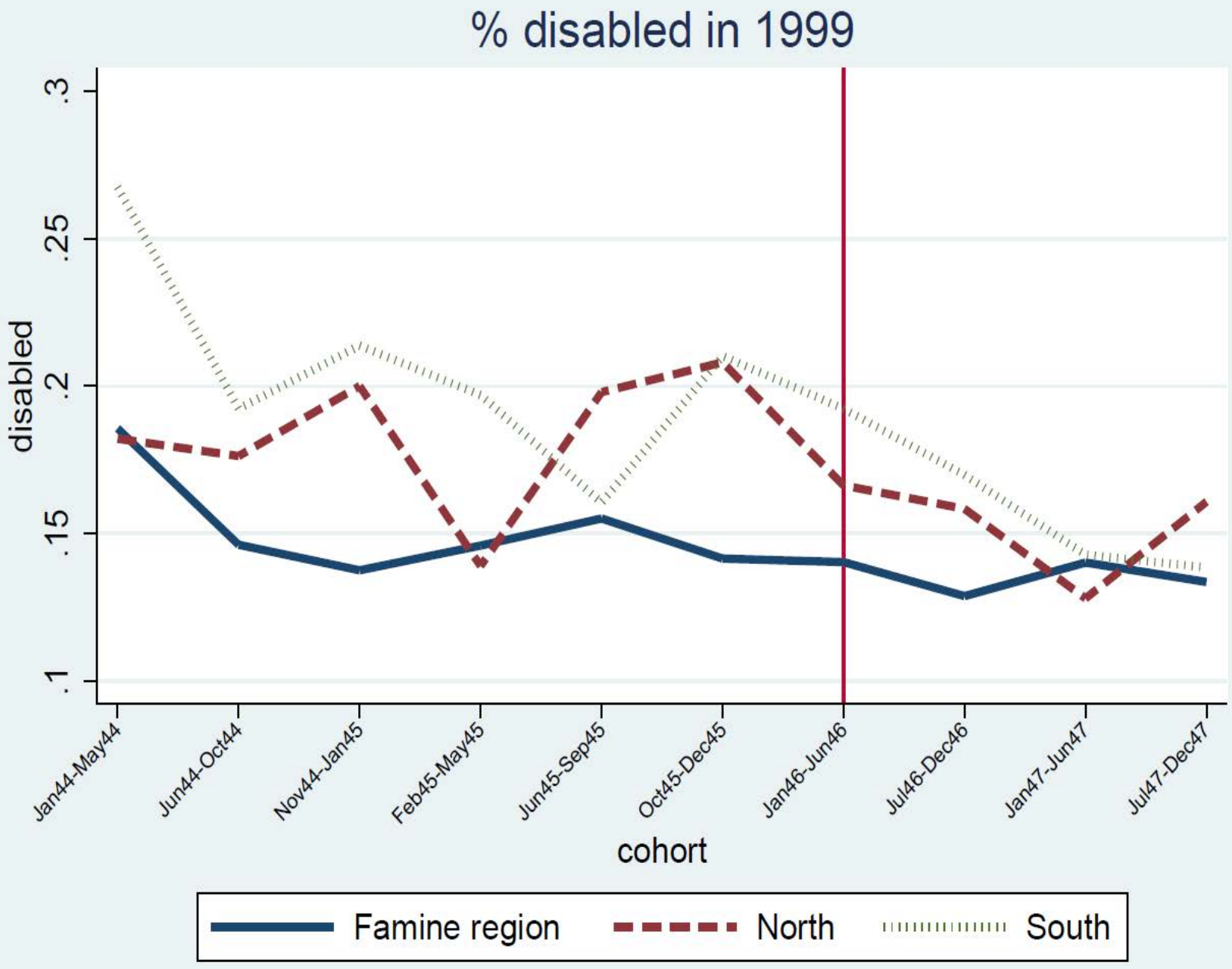
Effect of famine on socio-economic outcomes later in life (1999-2013).

- Socio-economic status
  (un)employment, retirement, disability
  Timing of retirement and disability
- Annual personal income
- Non-residential care use

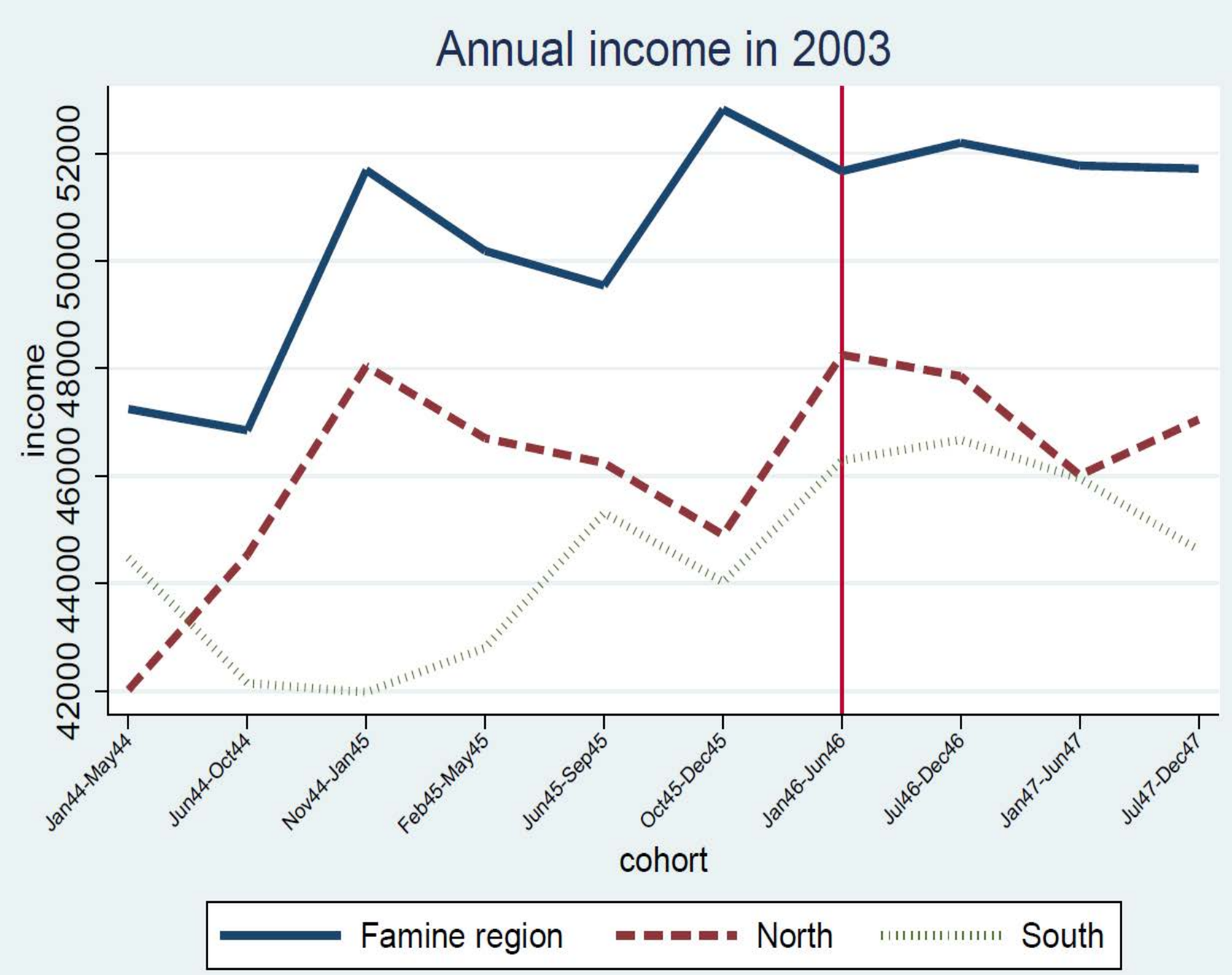
In Ravelli-cohorts

# Employment in 1999

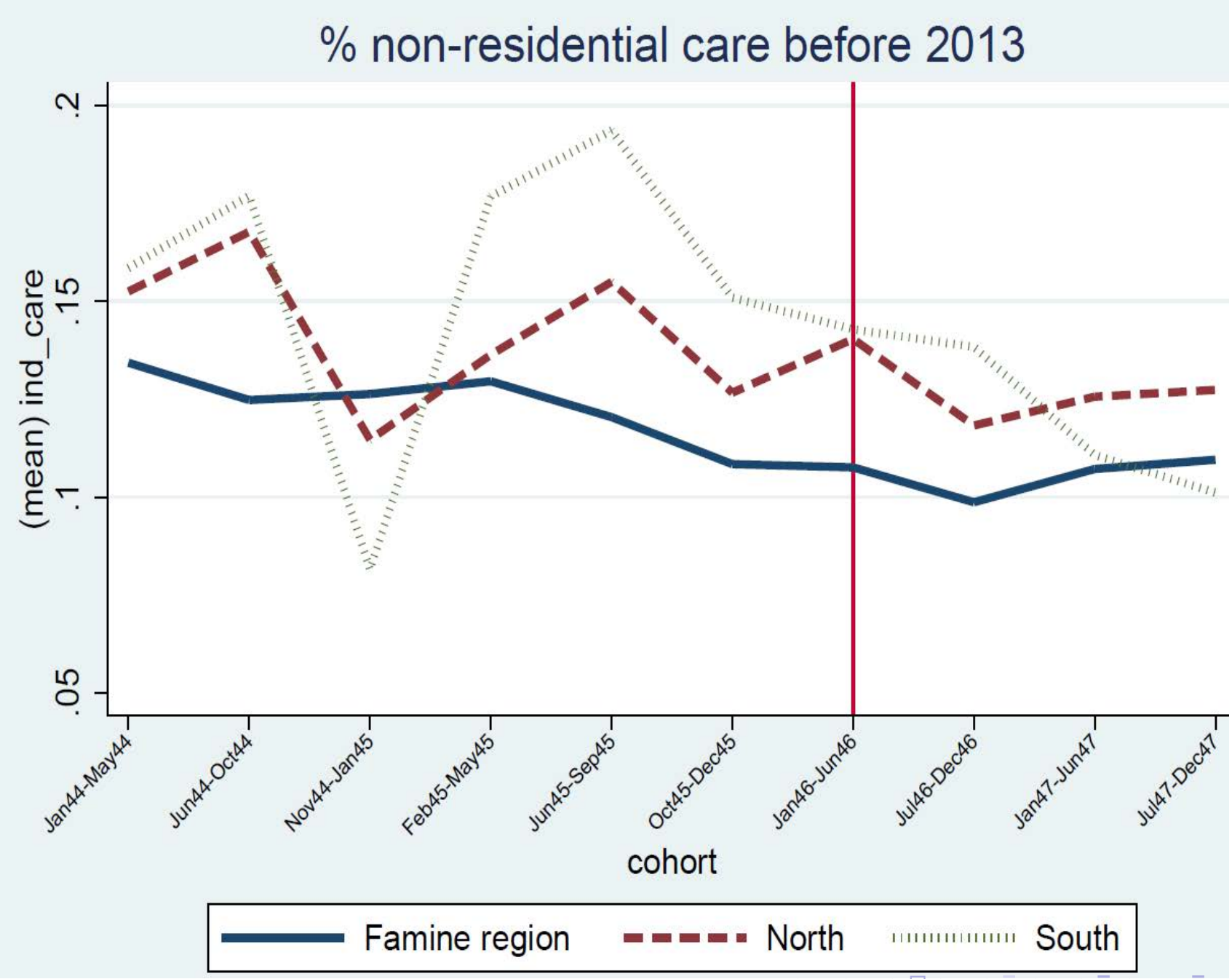
# Disabled in 1999



# Income in 2003



# Non-residential care 2003-2013



# Accounting for trends and background

**Difference-in-difference analysis**

Income & non-residential care

Ravelli-cohorts

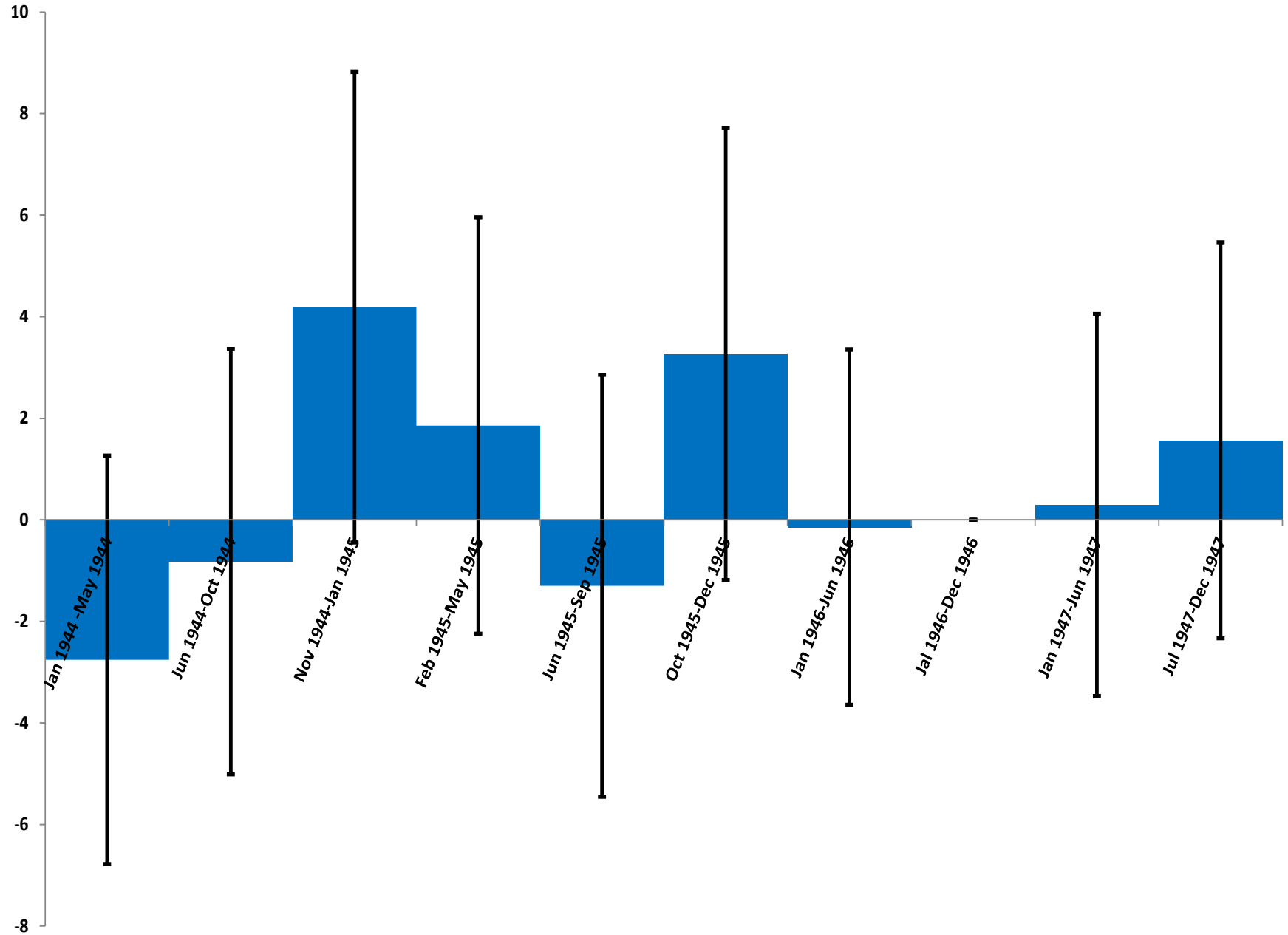
or

**Cox analysis of timing**

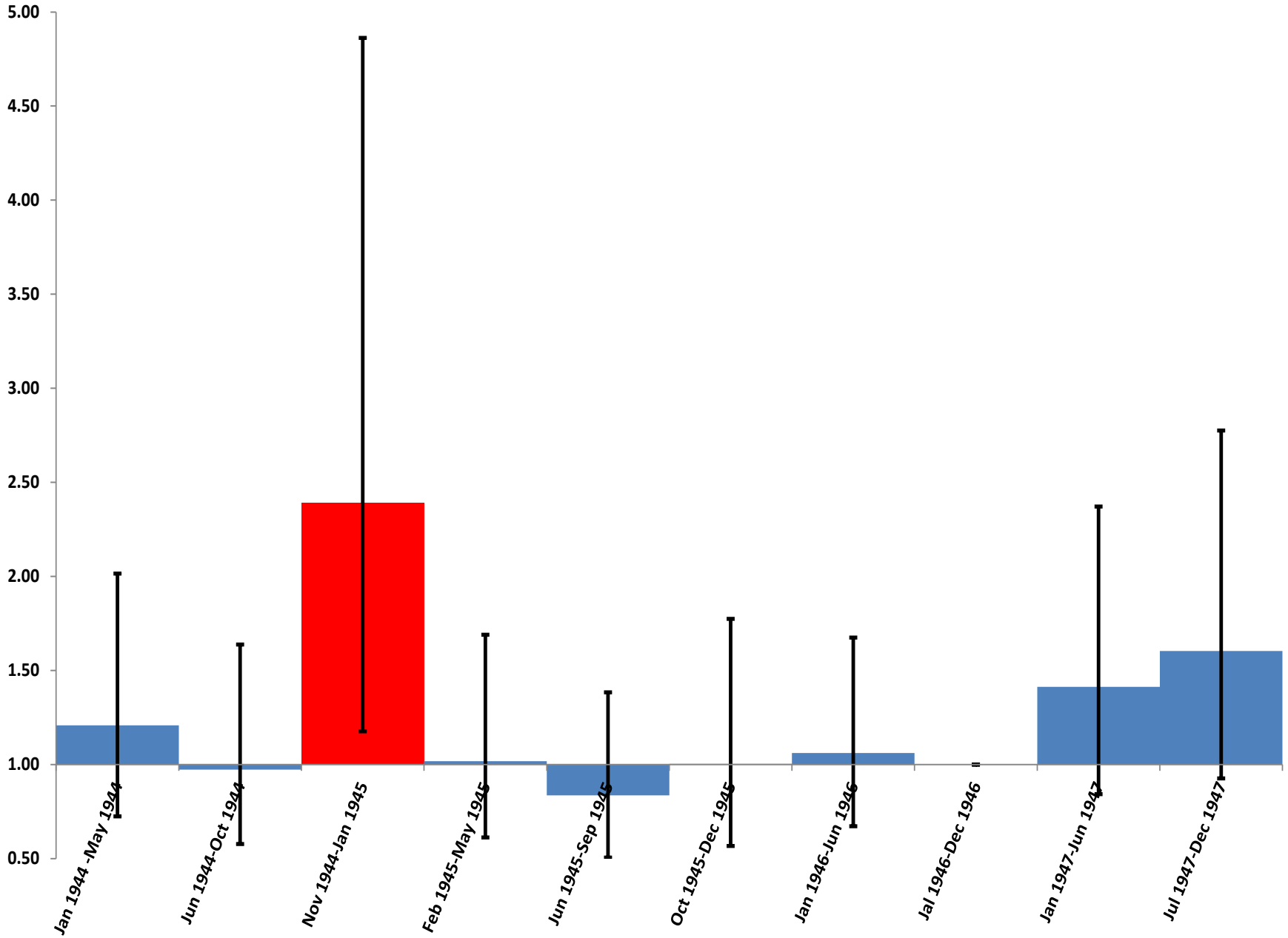
Retirement & disability

Overlapping-cohorts

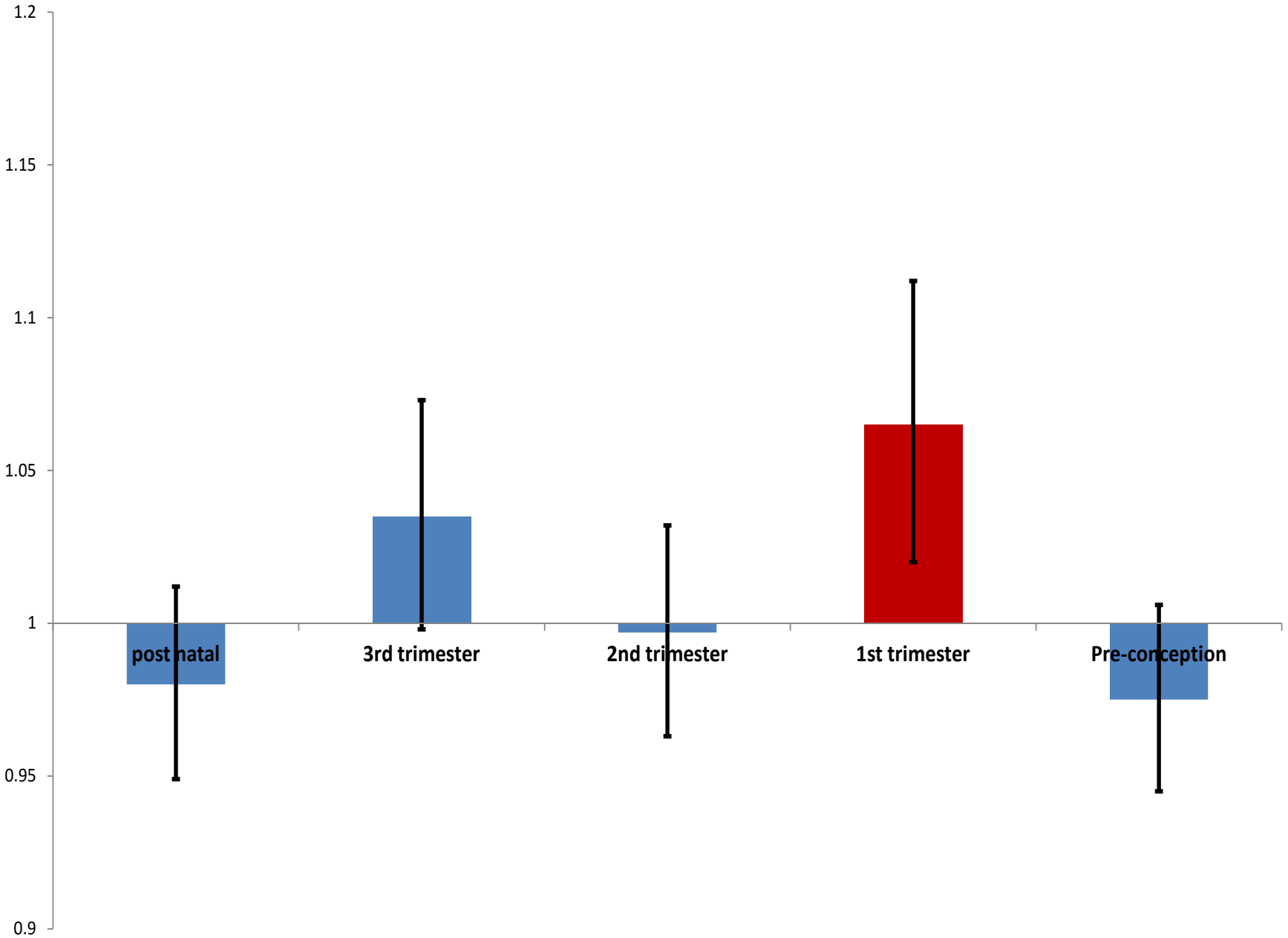
# Effect Famine on income



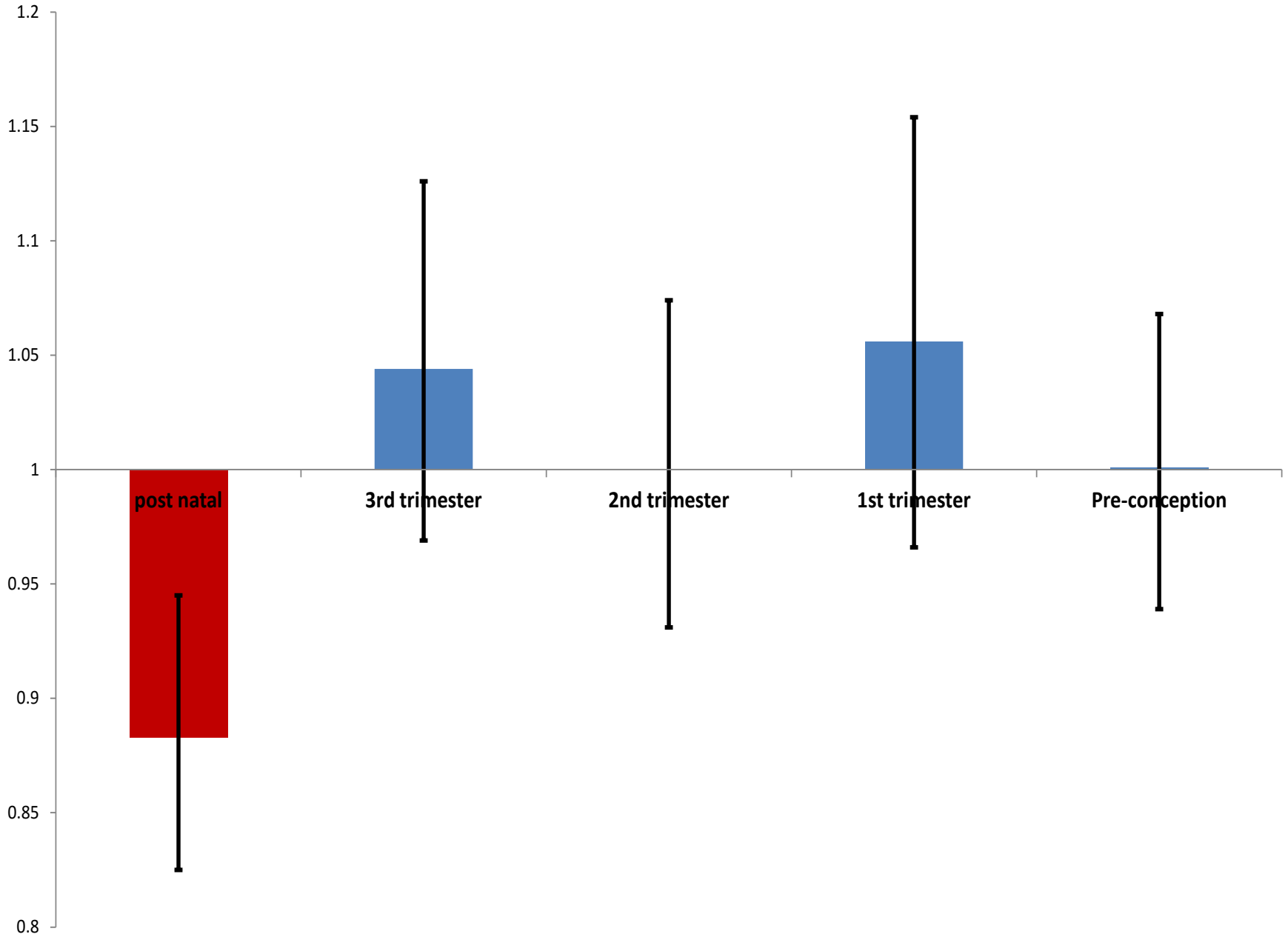
# Effect Famine on % ever using non-residential care, odds



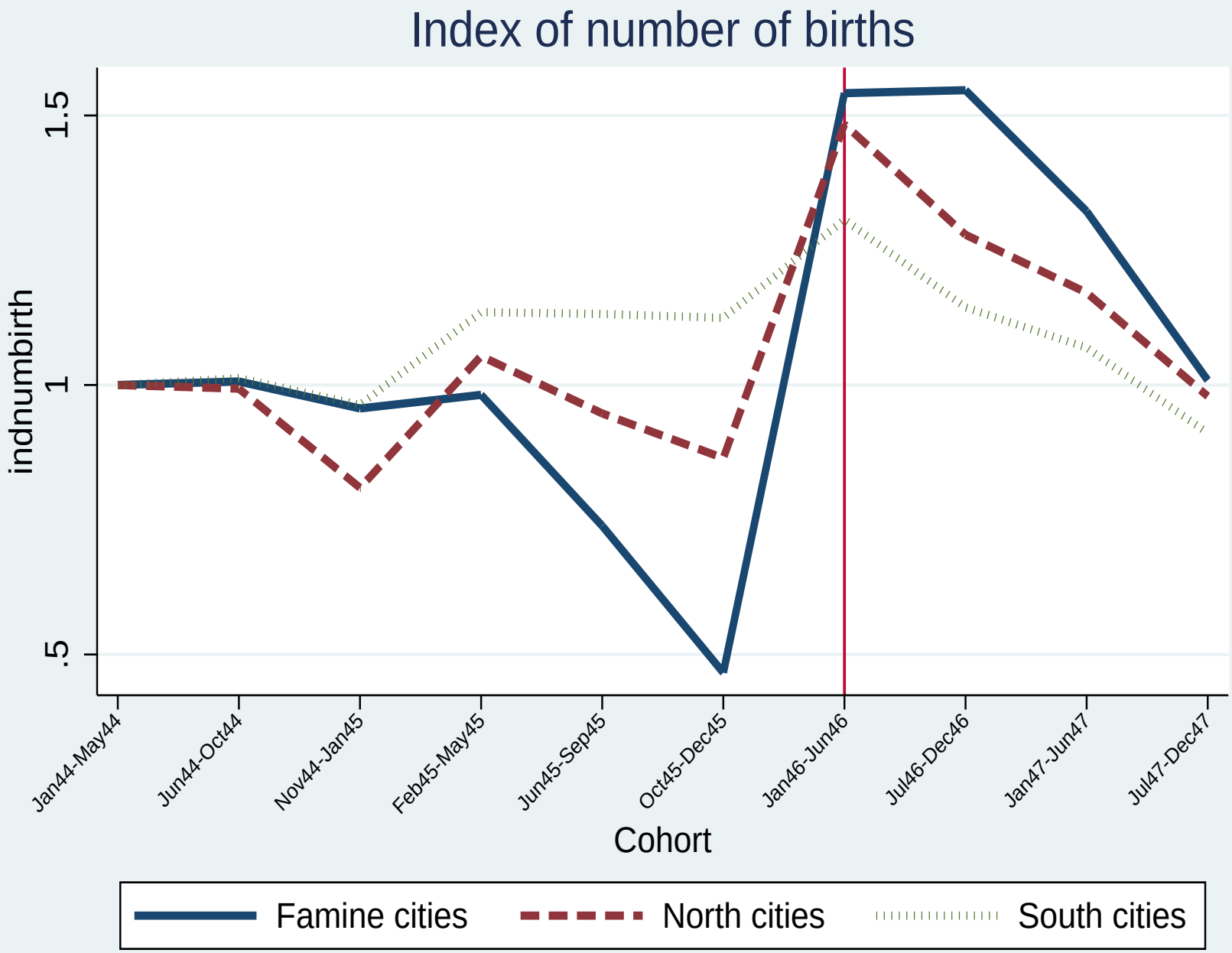
# Effect Famine on timing of retirement, Hazard ratio



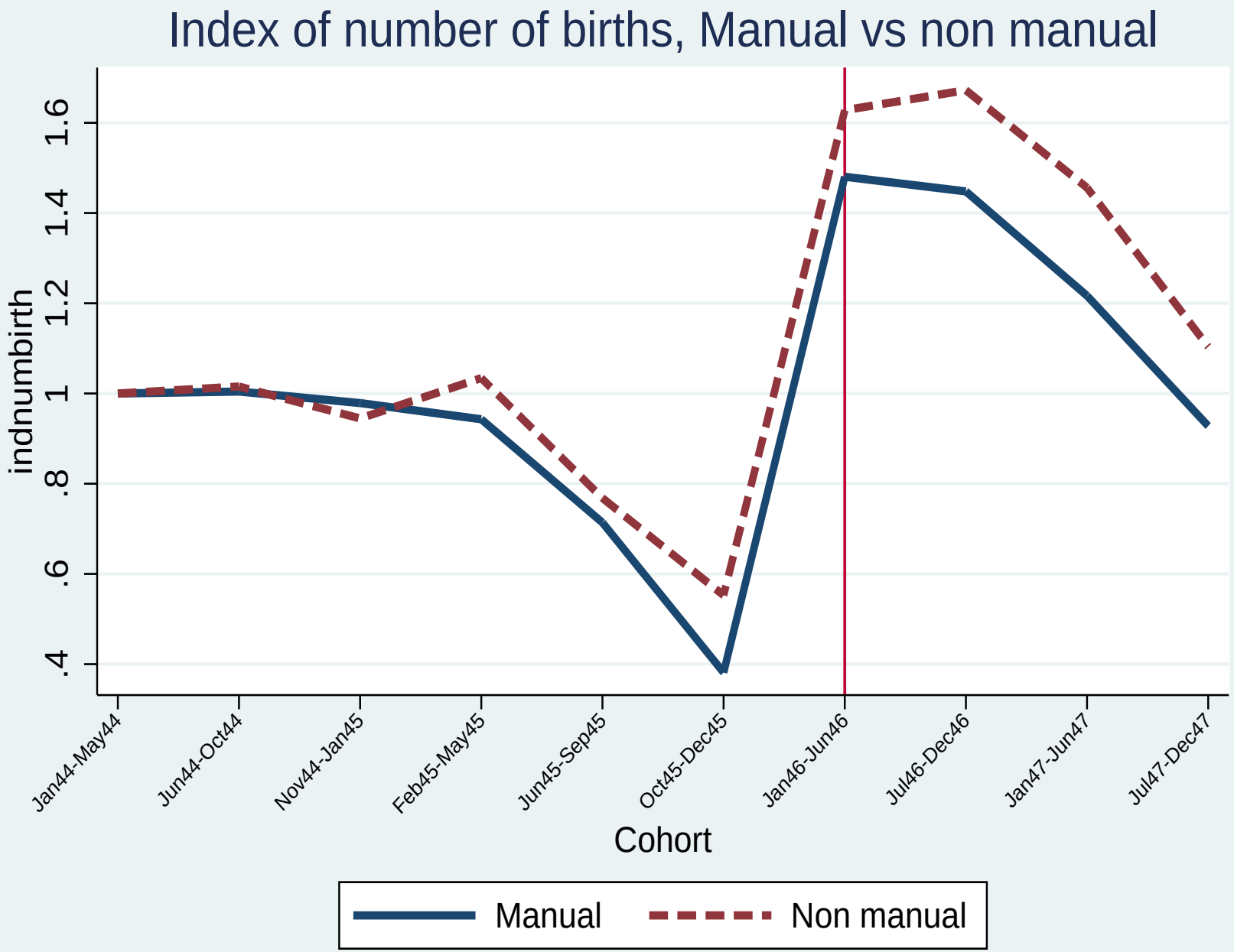
# Effect Famine on timing of disability, Hazard ratio



# Drop in births



# Drop in births: manual vs non-manual



# Discussion

- Famine (seems to) affect young adults: height, overweight, intelligence and education (Conception period)
- Famine affects mortality: exposure to famine in $1^{st}$ trimester increases mortality
  Specific causes: Other natural causes and external causes
- Famine (seems to) affect later life outcomes: non-residential care use and timing of disability (Post-natal) and retirement ($1^{st}$ trimester)
- Only men
  Boys tend to be biologically more sensitive to early-life nutritional conditions than girls (Kraemer (2000), Low (2001))
- **selective fertility and/or survival**

# Future research

- Accounting for selective fertility and other selection issues
- Development of lifecycle framework linking prenatal years to ageing
- Medication use, Insured costs covered by health insurance.

# Thank you for your attention

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