



# Inequality in Health

## Lecture VIII: Health and Education

Dr Martin Karlsson

University of Duisburg-Essen

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# Outline

- 1 Recap of Last Lecture
- 2 Introduction
  - The Facts
  - Empirical Challenges
  - Literature Review
- 3 Empirical Application: Fischer et al. (2021)
  - Introduction
  - Background
  - Method and Data
  - Data
  - Results I
  - Reforms Combined
- 4 Summary and Conclusions

## Recap of Last Lecture

# Recap of Last Lecture

- A growing literature evaluates the long-term health of early-childhood interventions.
- Several studies confirm shocks during childhood to have old-age impacts on health.
- Relatively low-cost home visiting programmes in Scandinavia during the 1930s were found to not only decrease infant mortality but also reduce deaths at old-age due to cardiovascular diseases or cancer.
- The conclusions of these studies might be important for today's developing countries.

# Introduction

# Introduction

- There are well-documented, persistent associations between **health** and **education** that hold across countries and over time.
- Better educated individuals are more likely to **survive** to old age, less likely to die from the most common acute and **chronic diseases** and less likely to report anxiety or **depression**.
- Health may also affect education through its effects on morbidity (illness-related school absence) or through effect on children's cognitive development.
- **Reverse causality** is a plausible concern in the education-health relationship.
  - Health → education: healthier children may get better grades and have a higher educational attainment than less healthy children.
  - Education → health: more educated individuals are also healthier.

# Life Expectancy by Education Level

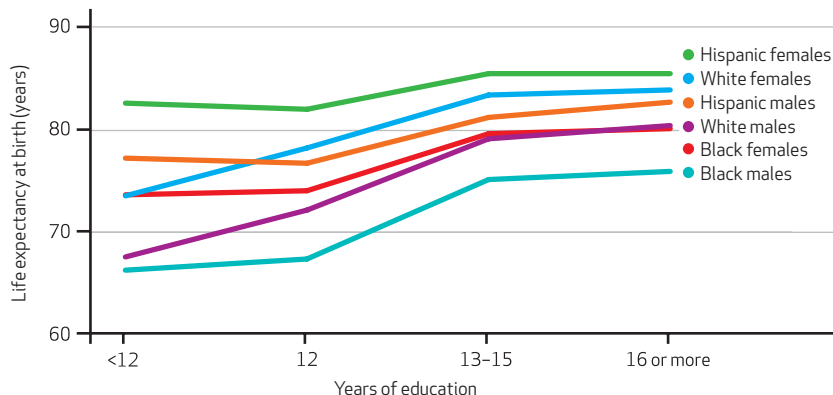


Figure 1. Life Expectancy at Birth, by Years of Education at 25, 2008

Source: Olshansky et al. (2012)

# Life Expectancy and Education

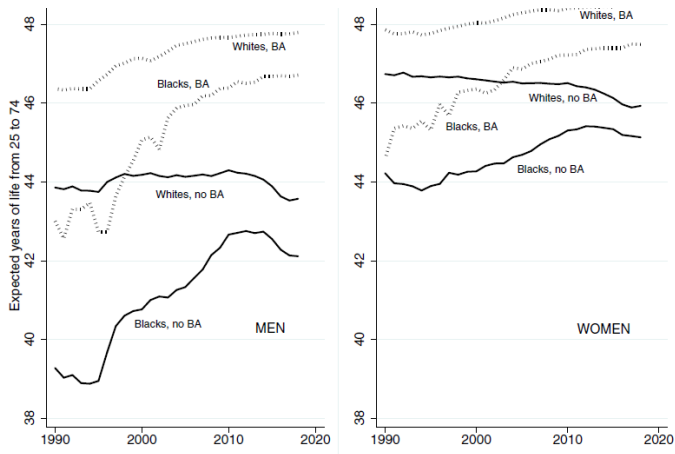


Figure 2. Expected years of life from 25 to 75 by BA status.

Source: Case and Deaton (2021)



# Mortality Rate by Education Level and Age

- Effects vary by **age**.  
Possible explanations:
- People with lower education less likely to survive into old age.
- Individuals who survive longer are relatively healthier (fewer differences w.r.t. more educated individuals.)
- Importance of education for health became relatively larger in recent years.

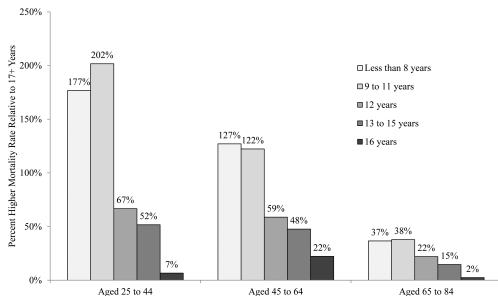


Figure 3. Mortality Rate Differences Relative to Individuals With 17+ Years of Education, U.S. Women, by Age.

Source: Hummer and Lariscy (2011)

# Education & Lifestyle

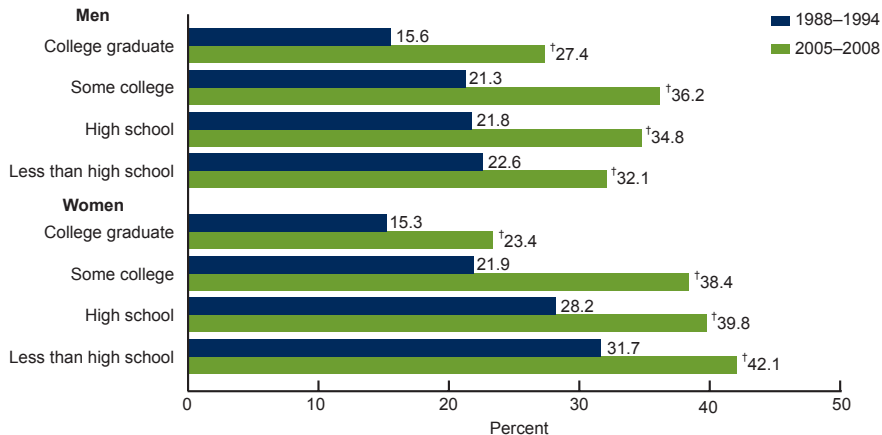


Figure 4. Prevalence of Obesity among U.S. Individuals Ages 20+, by Education.

Source: Ogden et al. (2010)

# Cause-of Death Heterogeneity by Education & Race

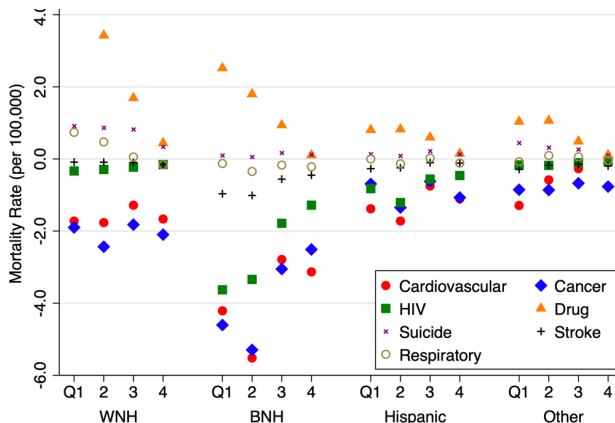


Figure 5. Estimates by Cause of Death for 25-64 Year Old Males, by Education.

Source: Leive and Ruhm (2022)

► Females

# Mediators and Confounders

- Several additional variables correlate with health and education.
- These are either mediators or confounders.
- **Mediators**
  - **Income:** greater financial resources guarantee better access to health care.
  - **Labor market:** e.g. job characteristics.
  - **Health behaviors:** more educated individuals are better informed, engage in more preventive behaviors (e.g. flu shots; mammography) and engage less in harmful behaviors (smoking).
- **Confounders**
  - **Family background:** parental education and investments in children can both increase schooling and improve health.
  - **Cognitive ability:** promotes healthy lifestyle and education.
  - **Risk and time preferences:** Ditto.
- In an empirical analysis, the distinction is essential.

# The Effect of Education on Health

Endogeneity issues are resolved using e.g. **natural experiments**, however the literature so far is **inconclusive**. Examples:

- **Compulsory schooling reforms:**

- Basu et al. (2018): Reform in England and Wales – different schooling systems affect depression risk and smoking probability.
- Kemptner et al. (2011): West German reforms from 1949–69 – education affects health outcomes like long-term illness (but not behaviors, e.g. smoking). Effects stronger for **men**.

- **Quarter of birth** widely used as an **instrument** for schooling (originally proposed by Angrist and Keueger, 1991); its validity has been challenged (cf. Buckles and Hungerman, 2013, for a review).
- Heckman et al. (2018) use **presence** of a 4-year **college** in a county (U.S. data) to **instrument** for the effect of education on earnings, health and health-related behaviors. **College proximity** is also a popular instrument.

# Literature Review: Studies Using School Reforms

Authors	Country	Year/Content of the Reform	Identification Strategy	Main Results
Albouy and Lequien (2009)	France	1936 (Zay Reform) / 6→7 1967 (Berthoin Reform) / 7→9	RDD	Zay Reform: Survival till 82 for those who survived till 1968 increased by 6% (Wald-estimate). Berthoin Reform: Survival till 52 for those who survived till 1968 increased by 1%(Wald-estimate). Effects <b>statistically</b> insignificant.
Gathmann et al. (2015)	Various European countries	19 different reforms	RDD	Substantial heterogeneity in time and space: Effects probably larger for reforms implemented earlier in the 20th century. Gender differences: No effects for women; reduction of 2.8% in 20 years male mortality from age 18 (reduced form).
Van Kippersluis et al. (2011)	Netherlands	1928 / 6→7	RDD	2-3% decrease in mortality till the age of 89 for those survived till the age of 81 (reduced form). Reduced form similar to two stage least squares.
Clark and Royer (2013)	England and Wales	1947 / 8→9 1972 / 9→10	RDD	Hardly any evidence for a reduction of mortality. Some estimates even with positive sign.
Meghir et al. (2018)	Sweden	Implemented by municipalities between 1949 and 1962. From 1962 nationwide. / (7 or 8)→9	Reduced Form DID / IV	Short-lived gain in expected male years of life from a shift in mortality from ages 45-50 to ages 50-55. Overall life expectancy not significantly affected. Heterogeneity with respect to social background.
Lleras-Muney (2005)	U.S.	1915 - 1939 Various U.S. States with different extensions.	DID / IV RDD	Extension of one year of education decreases 10 year mortality for those surviving till 1960 by 3.6% (IV) relative to a baseline mortality of 10%. Estimates challenged by Mazumder (2012): Sensitive to state-specific time trends.
Malamud et al. (2021)	Romania	Implemented: late 50s - early 60s Universal from 1962 4 →7	Di-Disc	Null results. Overall all-cause mortality not significantly affected.

# The Effect of Health on Education

- **Twin studies:** Black et al. (2007): twin data from Norway show that better **health at birth** increases probability of completing high school; male earnings in adulthood; height and IQ.
- **Natural experiment:** Miller and Wherry (2019) exploit the **coverage expansion** of Medicaid toward pregnant women. Benefited individuals that were in-utero during the policy change had increased high school graduation rates.
- **Genetic Index:** Papageorge and Thom (2020): Education related **polygenic score** predicts BA studies (effect stronger for high SES).
- **RDD:** Bharadwaj et al. (2013) exploit Very Low Birth Weight classification which causes an assignment of special care to infants. Children who receive extra care at birth have higher test scores and school grades.

## Empirical Application: Fischer et al. (2021)



# Empirical Application: Fischer et al. (2021)

- Fischer et al. (2021) distinguish between **quality** and **quantity** of education.
- Use of two parallel school reforms in Sweden:
  - Both increased **compulsory schooling** by 1-2 years.
  - One also completely changed the **school system**.
- The study uses an **instrumental variable approach**...
- ...although the 2<sup>nd</sup> reform does **not** satisfy all **assumptions**.
- This creates **new insights** into the role of the **quality** of education.

# Background: Swedish School System Reforms

- **8-year reform:** Compulsory schooling increased from 7 to 8 years.
- **9-year reform:** Compulsory schooling increased to 9 years + **postponed tracking** (inequality of opportunity concerns).
- De-tracking broadens the ability composition of classrooms.
- Thus, 9-year reform changed the **quality of education**.
- Reform implementation varied by municipalities over time.

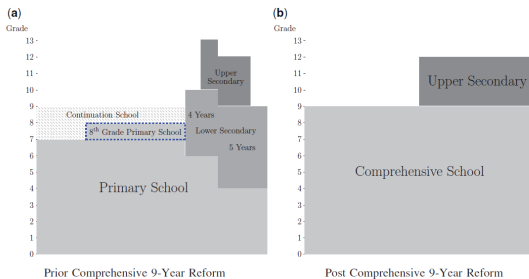


Figure 6. The Swedish School system

# Introduction of the reforms

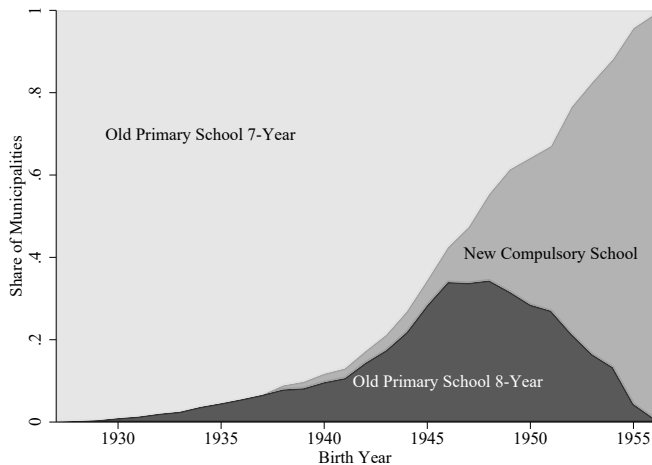


Figure 7. Proportion of school districts by reform status.

# Issue: Endogeneity

- As shown above: People with different educational backgrounds are not comparable because of
  - family background
  - preferences
  - intelligence
  - neighbourhood
  - etc.
- Consequence: **correlation** between education and health is a **combination** of
  - ① Effect of **education**, and
  - ② of these various **background factors** (*confounders*)
- Distortions (2) are typically **positive: overestimation** of the effect.

# Assumption

- **Causal effect:** Difference between an actual state and an alternative state (**countefactual**)
  - But you are either affected by the schooling reform or not!
  - We determine the hypothetical outcome in this counterfactual state:

$$\text{Effect}_i = H_i^1 (\text{Additional Education}) - H_i^0 (\text{Baseline Education}) \quad (1)$$

- This alternative scenario is called “*missing counterfactual*”.
- DID assumption: **parallel trends**.
- Formally:

$$ITT = \mathbb{E} (H - H^0 \mid T = 1, D = 1) \quad (2)$$

$$\begin{aligned} \mathbb{E} (H^0 \mid T = 1, D = 1) &= \mathbb{E} (H \mid T = 0, D = 1) \\ &+ \mathbb{E} (H \mid T = 1, D = 0) - \mathbb{E} (H \mid T = 1, D = 0) \end{aligned} \quad (3)$$

# Difference-in-Differences

$$\hat{\tau}_{DID} = \overline{H}_1^T - \overline{H}_0^T - [\overline{H}_1^C - \overline{H}_0^C]$$

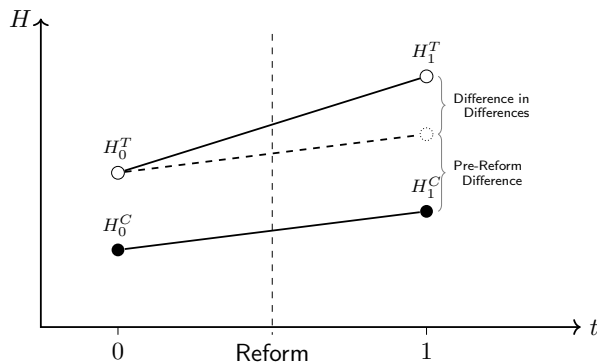


Figure 8. Difference in Differences.

# Data Sources

- ❶ **Swedish Administrative Data** (individual level)
  - Censuses (1960, 1970)
  - Swedish Death Register
  - Sample Restrictions: Cohorts born 1932–1952.
- ❷ **Intervention Data** (schooling reforms)
  - Year a municipality increased schooling to 8 years.
  - Year of introduction of the new comprehensive school system.
- ❸ **ULF Survey data**
  - Self-reported health/behavioral variables.

## Data

Table 1. Descriptive Statistics

	<i>All</i>	<i>Low SES</i>	<i>High SES</i>
PANEL A: ADMINISTRATIVE DATA			
Years of Education	9.9	9.4	11.2
Dead	0.168	0.161	0.130
<i>Cancer</i>	0.063	0.062	0.052
<i>Lung cancer</i>	0.010	0.010	0.008
<i>Circulatory diseases</i>	0.040	0.040	0.028
<i>Diabetes</i>	0.003	0.003	0.002
<i>Mental disorder</i>	0.003	0.003	0.002
<i>Liver disease</i>	0.003	0.003	0.002
N	1,505,957	931,668	394,211
PANEL B: SURVEY DATA			
Years of Education	10.0	9.5	11.2
N	24,112	15,124	6,597
Fair or bad health	0.232	0.244	0.190
N	24,039	15,077	6,580
Smoke daily	0.236	0.239	0.228
N	23,881	14,972	6,550
Obesity	0.110	0.118	0.089
N	14,008	8,770	3,856
Anxiety disorder, concern, etc.	0.148	0.152	0.139
N	16,261	10,164	4,508



# The First Stage: Duration of Schooling

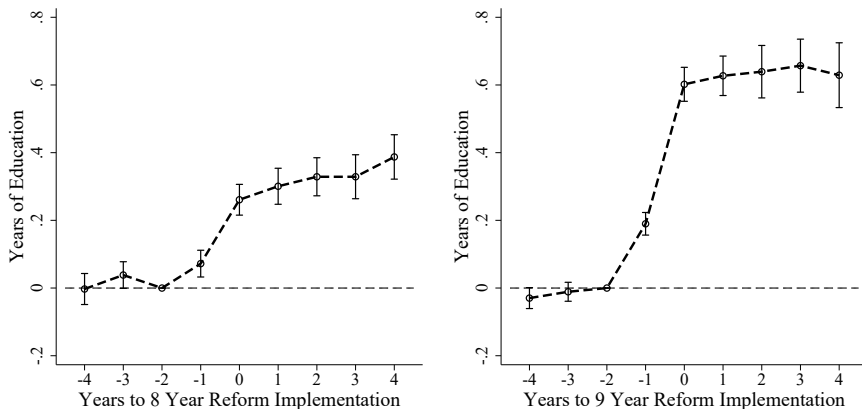


Figure 9. Effect of the reforms on the length of schooling.

# DID-IV

- DID estimates the effect of a **reform**.
- But we are interested in the effect of **years of education**.
- **Solution:** DID-IV:

$$E_{icd} = \gamma Reform_{ic} + W_c + M_d + \epsilon_{icd} \quad (FS)$$

$$H_{icd} = \delta Reform_{ic} + Q_c + N_d + v_{icd} \quad (RF)$$

- Under certain conditions,  $\delta/\gamma$  captures
  - The effect of one year of education on health...
  - ...for people who change their education because of the reform.
- Assumptions (**LATE theorem**):
  - ① The instrument ( $Reform_{ic}$ ) is **independent** of individual features.
  - ② The effect runs **only** over years of training (**exclusion restriction**).
  - ③ Nobody **reduces** schooling because of the reform (**monotonicity**).

# Effects on Mortality

Table 2. Mortality until 2013

	(1)	(2)	(3)
	WHOLE SAMPLE	LOW-SES	HIGH-SES
RF 8-Years Reform Impact	-0.004** (0.002)	-0.004* (0.002)	-0.006** (0.003)
RF 9-Years Reform Impact	0.002 (0.002)	0.001 (0.002)	0.002 (0.002)
IV 8-Years Reform	-0.015** (0.006)	-0.015* (0.008)	-0.032** (0.016)
IV 9-Years Reform	0.003 (0.003)	0.001 (0.003)	0.005 (0.007)
Mean	0.168	0.161	0.130
N	1,505,957	931,668	394,211

# Results by Cause of Death I

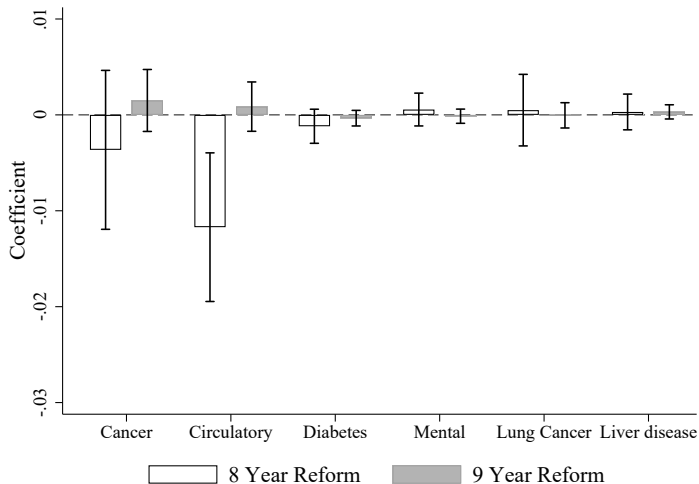


Figure 10. IV reform effect on various causes of death.

# Results by Cause of Death II

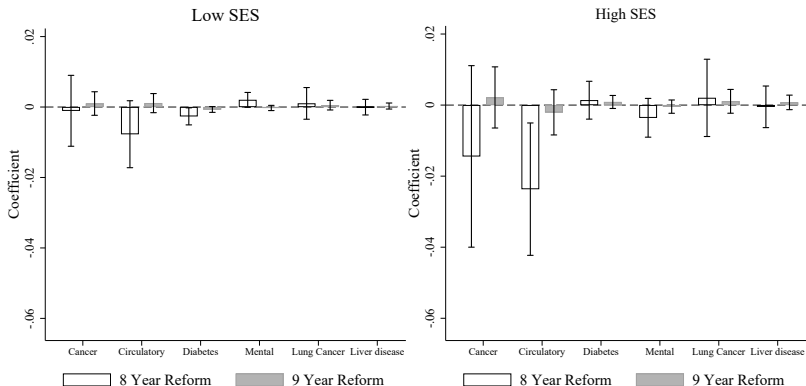


Figure 11. Impact of the reforms on cause-specific mortality by family SES

# Comparison

- The **similarities** of the reforms:
  - **Initial situation** identical: the same school system.
  - Implemented in **parallel** a few years apart.
  - Similarly-sized extensions of **schooling**.
- But **very different effects** on health
  - 8-years reform: mortality **-1.5%**, significant.
  - 9-years reform: positive, small, not significant.
- How can we **explain** this?
- Is it because of the **differences** between the reforms?
- During the 9-year reform, the **school system** was completely rebuilt: only **comprehensive schools**.

# Comparison of the effects

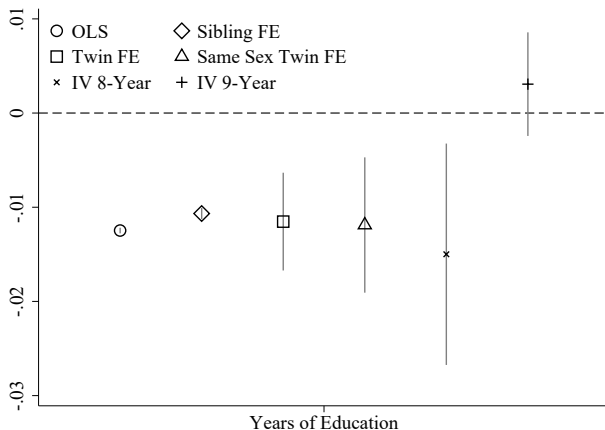


Figure 12. Health effect of one school year: different strategies.

# The LATE Assumptions

- According to the LATE theorem: IV estimation as a causal effect, provided:
  - **Independence:** Instrument as good as random.
  - **Exclusion:** Effect only over school years.
  - **Monotonicity:** Nobody **reduces** the school years because of the reform.
- **Exclusion restriction not** satisfied for the 9-year reform!
  - **Everyone** was affected by the reform – even those who prefer 10+ years.
  - Changes in class composition, etc.
- Can we use this somehow?



# Empirical Methodology

- Reminder: DID-IV:

$$E_{icd} = \gamma Reform_{ic} + W_c + M_d + \epsilon_{icd} \quad (FS)$$

$$H_{icd} = \delta Reform_{ic} + Q_c + N_d + v_{icd} \quad (RF)$$

- Effect of an additional school year:  $\beta$ .
- Effect of the **8-year reform**:
  - For compliers:  $Effect_i = \beta$
  - For all others:  $Effect_i = 0$
  - So:  $\delta/\gamma = \beta$
- Effect of the **9-year reform**:
  - For compliers:  $Effect_i = \beta + \text{remainder}$
  - For all others:  $Effect_i = \text{remainder}$
  - So:  $\delta/\gamma = \beta + \text{remainder}/\gamma$
  - Thus:  $\text{remainder} = \delta - \beta \cdot \gamma$

# Combined Results: Mortality

Table 3. Effect on mortality

	(1)	(2)	(3)
	ALL	LOW-SES	HIGH-SES
RF 8-Years Reform Impact	-0.004** (0.002)	-0.004* (0.002)	-0.006** (0.003)
RF 9-Years Reform Impact	0.002 (0.002)	0.001 (0.002)	0.002 (0.002)
IV 8-Years Reform Impact	-0.015** (0.006)	-0.015* (0.008)	-0.032** (0.016)
IV 9-Years Reform Impact	0.003 (0.003)	0.001 (0.003)	0.005 (0.007)
<b>Rest</b> ( $\delta - \beta \cdot \gamma$ )	0.010*** (0.004)	0.010* (0.006)	0.013** (0.006)
Mean	0.168	0.161	0.130
N	1,505,957	931,668	394,211

# Combined Results: Other Outcomes

Table 4. Effects on other outcomes

	Normal/poor health (1)	Smoking (2)	Obesity (3)	Anxiety disorder (4)
RF 8-Years Reform	-0.022 (0.014)	-0.001 (0.017)	-0.027 (0.017)	-0.007 (0.018)
RF 9-Years Reform	0.016 (0.014)	0.001 (0.015)	0.011 (0.015)	-0.014 (0.016)
IV 8-Years Reform	-0.062 (0.041)	-0.001 (0.048)	-0.066 (0.046)	-0.018 (0.043)
IV 9-Years Reform	0.033 (0.030)	0.001 (0.030)	0.022 (0.032)	-0.027 (0.032)
<b>Rest</b> ( $\delta - \beta \cdot \gamma$ )	0.048* (0.029)	0.001 (0.031)	0.045 (0.044)	-0.005 (0.031)
Mean	0.232	0.236	0.110	0.148
N	24,038	23,880	13,997	16,256

## Summary and Conclusions

# Summary and Conclusions

- Health and education: strong positive correlation, robust
  - ...over time
  - ...across countries
  - ... for any health outcome (SAH, mortality, obesity, etc).
- **Endogeneity problem** due to
  - ① Reverse causation: health affects education.
  - ② Omitted variables: time and risk preferences, family background, etc.
- School reforms have been used to estimate the **causal effect** of education towards health.
- Fischer et al. (2021) evaluate two educational reforms that affected the **quantity** or both **quality and quantity** of education.
- Increasing quantity improves the longevity.
- Increasing classroom heterogeneity impacts quality and is associated with **worse health**.

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# Cause-of Death Heterogeneity by Education & Race

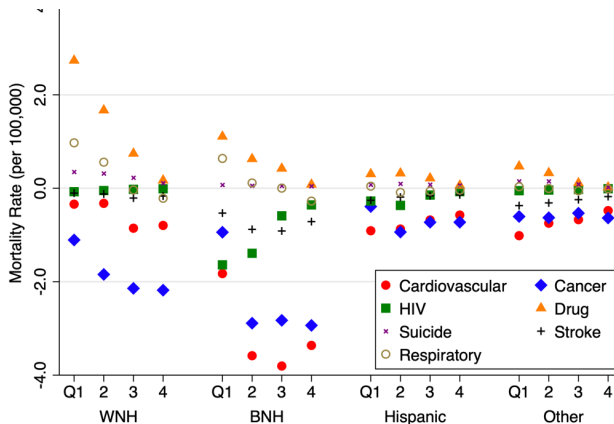


Figure 13. Estimates by Cause of Death for 25-64 Year Old Females, by Education.