Quantifying social inequalities in disease burden

Using linked individual-level data

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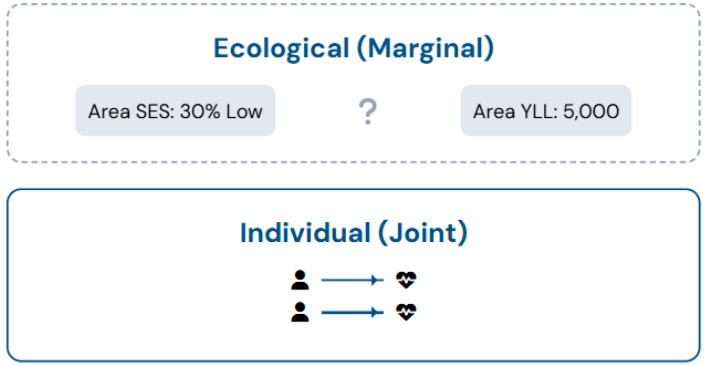
European Burden of Disease Network | May 2026

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Socioeconomic Drivers of Inequality

Individual-Level vs. Area-level - Data

Features	Ecological	Individual
Synonyms	Area/ Spatial/ Aggregate	Linked
Unit of Analysis	Area/Group Averages	Person-level Attribution
Temporal Link	Cross-sectional Snapshots	Longitudinal (Life-course)
Data	Marginal Distributions	Joint Distributions
Cost	Low cost	High cost
GDPR - Privacy	Standard	Strict

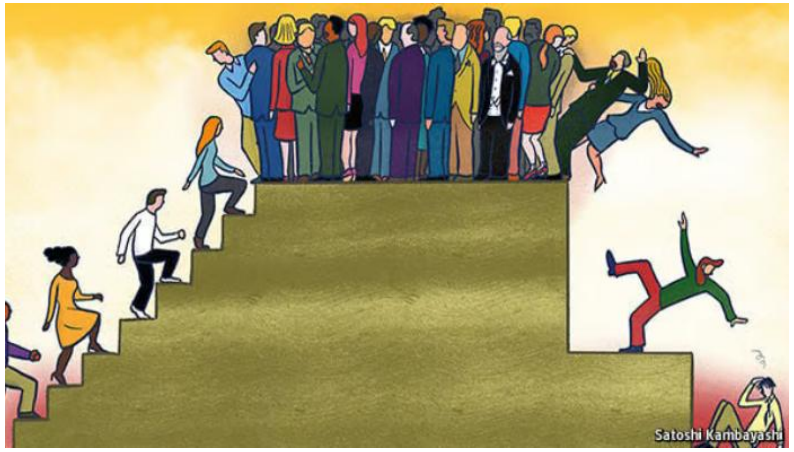


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Approaches to Using Individual-Level Data in Social Inequality in BoD

- Comparative risk assessment - The PAF approach
  - Treats SES as a risk factor; uses Relative Risks.
  - "Counterfactual"—how much burden would disappear if everyone was high-educated?
  - Makes strong causal assumptions
- The Individual cohort (Study 1)
  - Direct observation of life-courses and interactions (e.g., intergenerational effects).
- The Hybrid BoD Approach (Study 2)
  - Aggregates linked data to show the actual observed burden over time.
  - Provides an aggregated perspective of social inequalities by disease burden
  - Avoiding the heavy assumptions of causality required by PAFs.

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Baravelli, et al., Intergenerational education and premature mortality in Norway, 1990–2019: a nationwide cohort study

Case Study 1: Intergenerational Mobility

A Pure Individual-Level Cohort Study (Norway, 1990–2019)

Carl Michael Baravelli, Ann Kristin Skrindo Knudsen, Terje Andreas Eikemo, Ingeborg Forthun, Mirza Balaj, Christian Madsen, Claire Henson, Emmanuela Gakidou

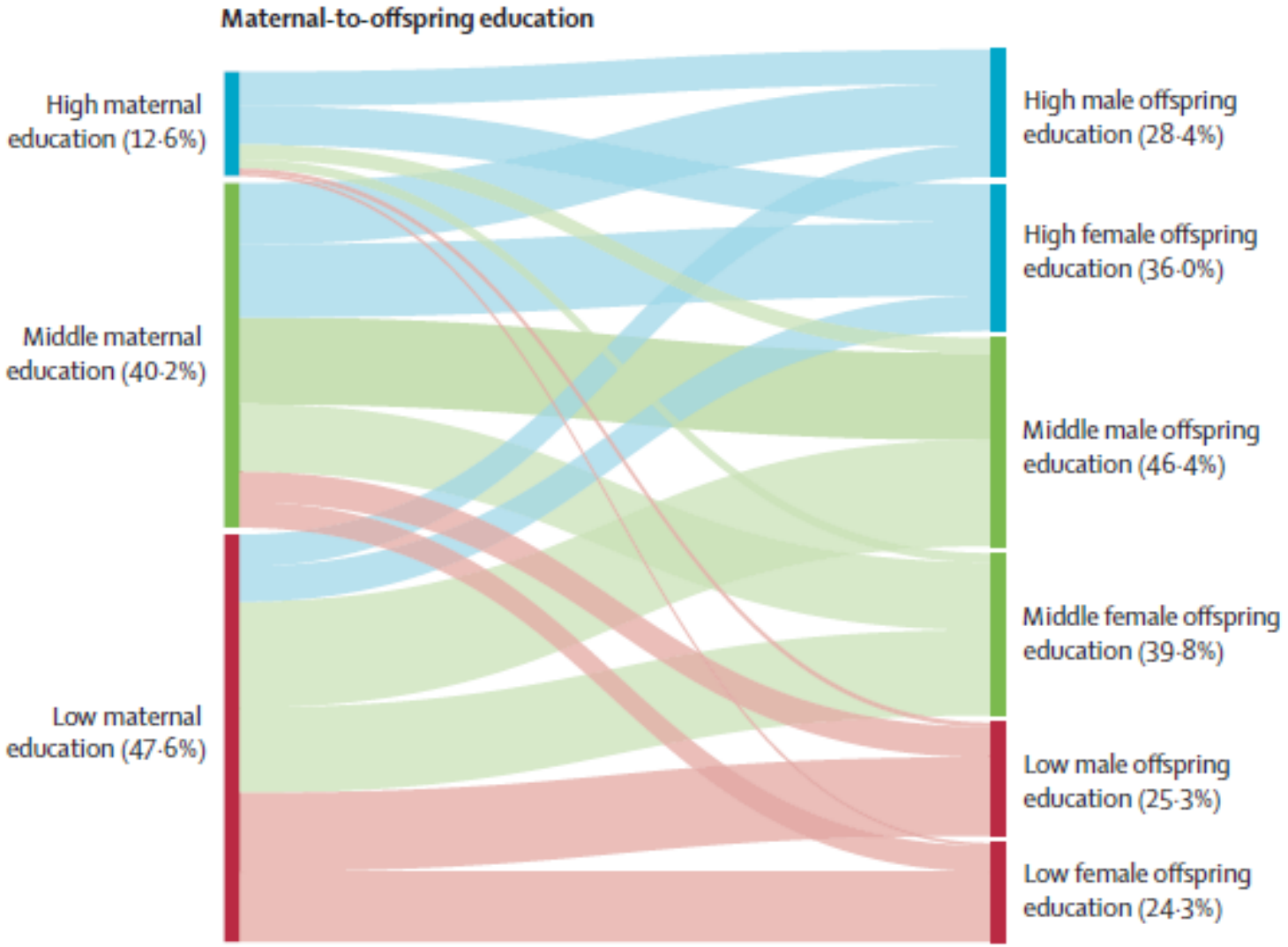
Study 1: Design & Population

Population	Observation	Events
2.9M aged 30-70y	54.7M Person-Years	162k Premature Deaths

- **Linkage:** Maternal/Paternal records → linked to offspring → linked to death registry.
- **Education:** Low (<Upper Sec), Middle (Upper Sec), High (Tertiary).
- **Exposure:** 9 parental–offspring educational combinations.
- **Outcome:** All-cause premature mortality ≤70 stratified by sex and cause.
- **Model:** Cox proportional hazards with age as timescale aggregated by birth cohort.

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Maternal to offspring education



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Mortality Risks Across 9 Life-Course Pathways

Low personal education associated with the highest mortality risks; especially among those from high-educated families.

Key Findings:

Low-educated individuals have the highest mortality risks, regardless of parental background

↘ Downward Mobility:

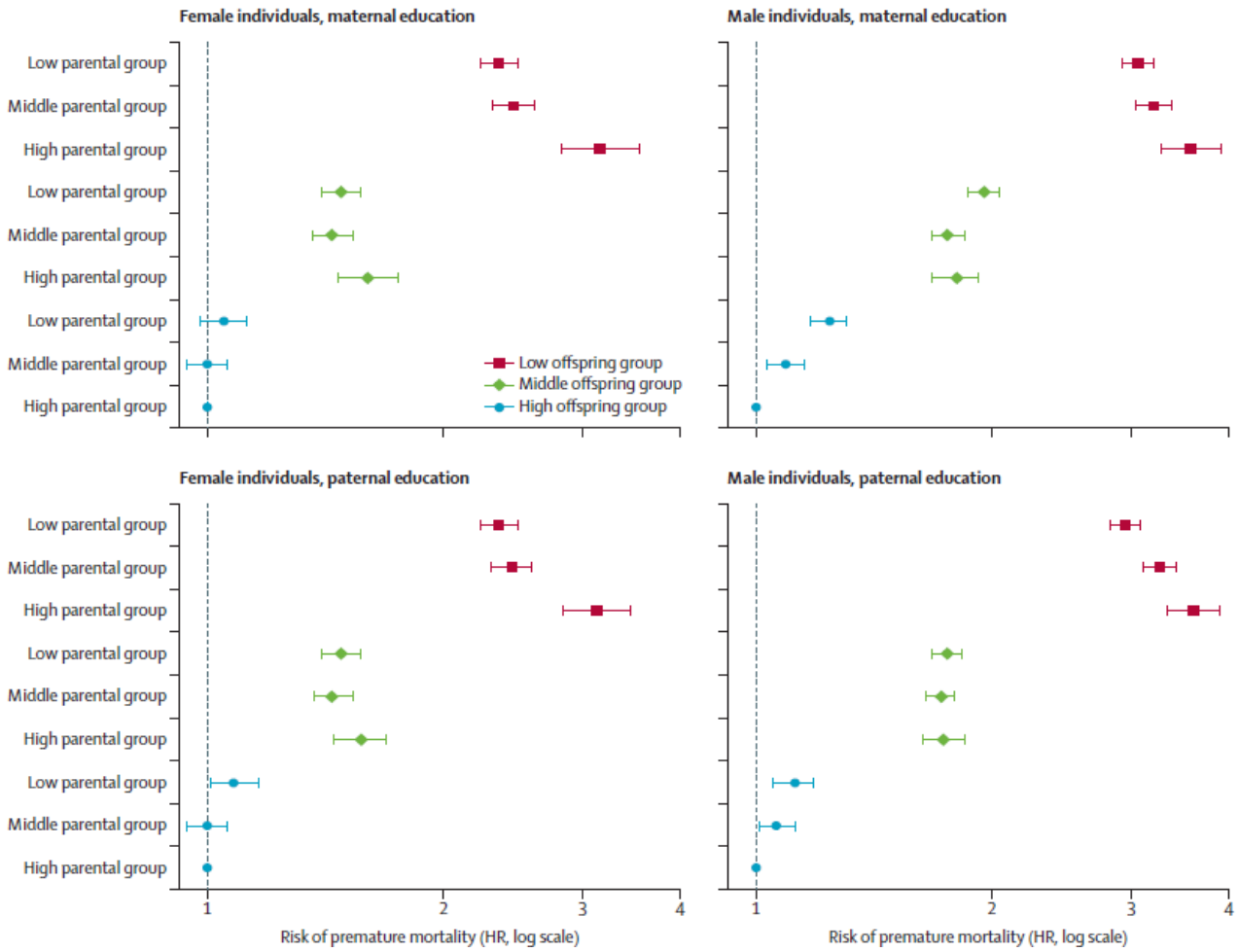
Rare, but associated with the highest mortality risks.

↗ Upward Mobility:

Strongly protective, yet "Stable High" groups still fared.

🧬 Parental Legacy:

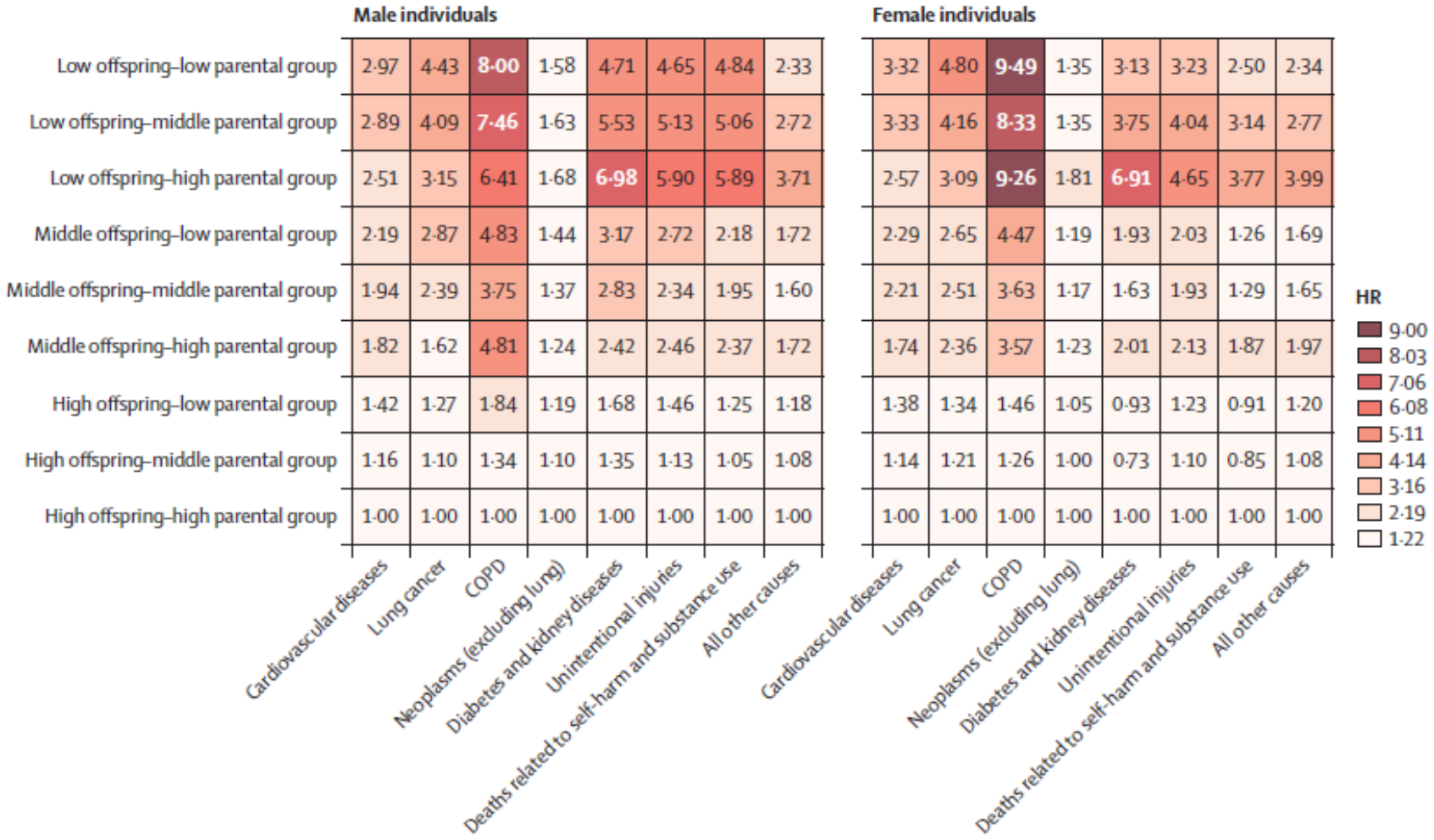
Parental education showed some lasting associations.



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Cause-specific patterns

Educational inequalities were evident across all investigated causes





Case Study 2: Bridging Individual Data and BoD Metrics

30 Years of Educational Inequalities in Years of Life Lost (YLL) in Norway (1990–2021)

Study 2: Bottom-Up Design

National Registry Study (1990-2021)

Every death certificate linked to personal education records via unique ID

GBD level-3

Causes of death classified by GBD level-3 (~130 causes)

Exposure

Education (low, middle, high)
Own education ≥28y
Parental education <28y

Outcome

Age-standardised YLL Rates based on GBD Life Tables resulting in Year-Sex-Age-Education specific YLLs

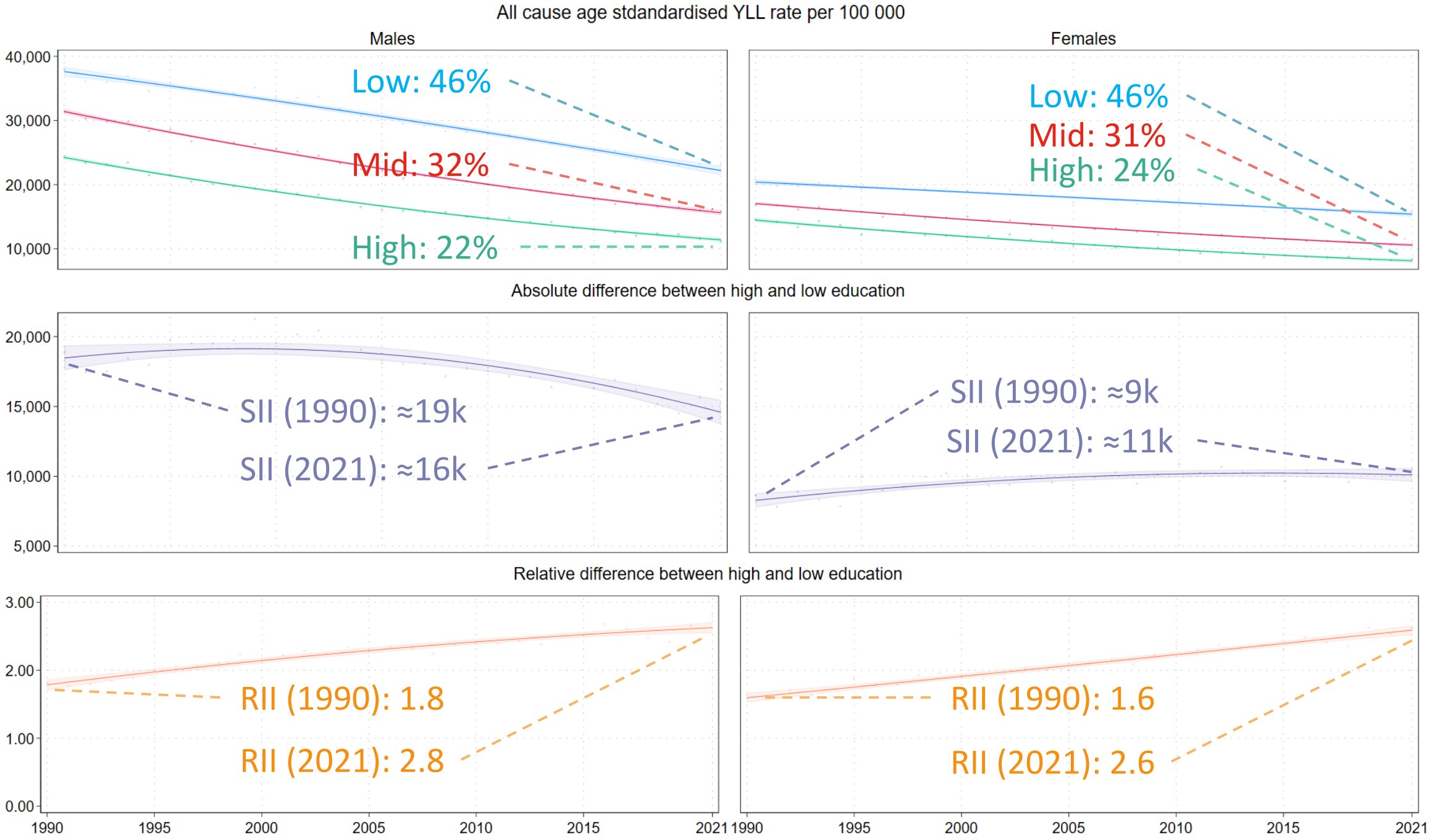
Inequality Measures

Absolute gaps: Slope Index of Inequality (SII)
Relative Gaps: Relative Index of Inequality (RII)

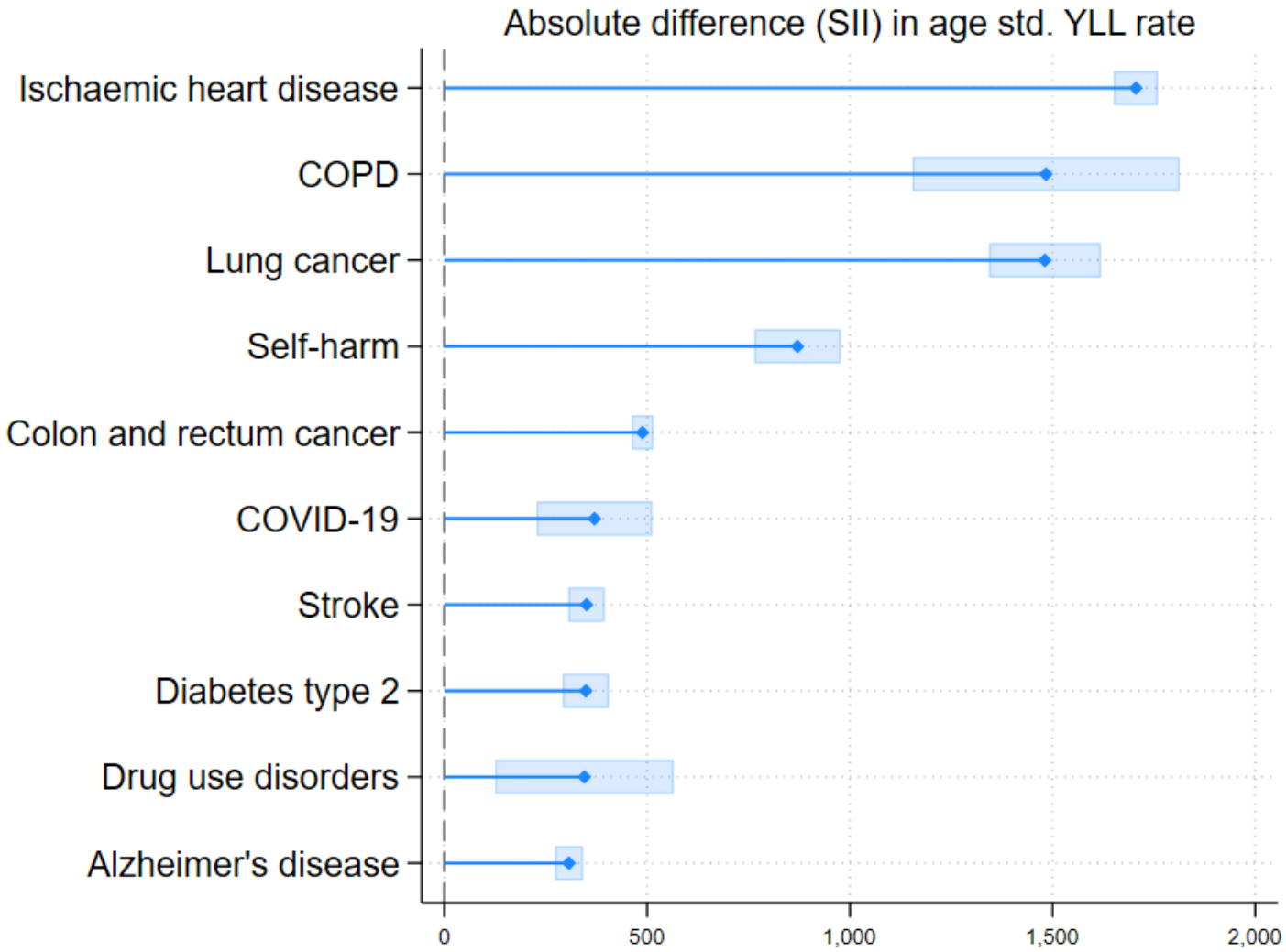
Temporal Measures

Joinpoint regression to calculate Average Annual Percent Changes (AAPCs)

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All cause age stdandardised YLL rate per 100 000
Males
Females
40,000
30,000
20,000
10,000
Low: 46%
Mid: 32%
High: 22%
Low: 46%
Mid: 31%
High: 24%
Absolute difference between high and low education
20,000
15,000
10,000
5,000
SII (1990): ≈19k
SII (2021): ≈16k
SII (1990): ≈9k
SII (2021): ≈11k
Relative difference between high and low education
3.00
2.00
1.00
0.00
RII (1990): 1.8
RII (2021): 2.8
RII (1990): 1.6
RII (2021): 2.6
1990
1995
2000
2005
2010
2015
2021

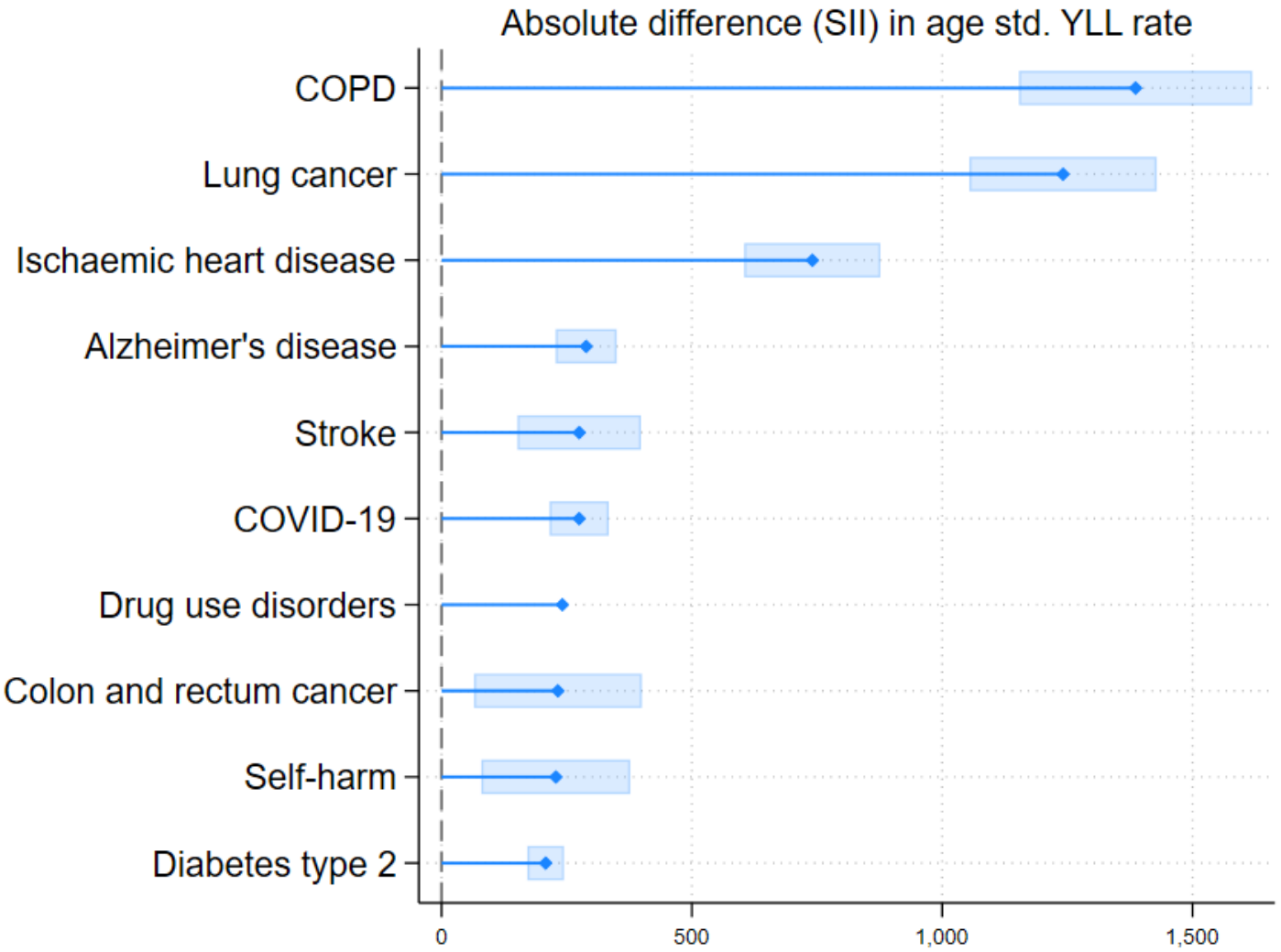
IHD, COPD, and lung cancer show the largest absolute gaps among men in 2021



Relative inequality (RII)	Reduced (-) / Incrased (+) absoluet inequlity (1990-2021)
2.4	-
10.2	+
5.3	+
3.1	+
2.2	+
3.1	-
2.1	+
8	+
15.7	-
1.4	+

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COPD, lung cancer and IHD show the largest absolute gaps among women in 2021



Relative inequality (RII)	Reduced (-) / Incrased (+) absoluet inequlity (1990-2021)
12.6	+
5.7	+
3.4	-
1.3	+
2.3	-
5.2	+
74	+
1.6	+
18.3	+
8.4	+

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Summary

Intergenerational Inequalities:

Offspring education is the primary driver of outcomes. But parental education acts as an important modifier. Life-course interactions matter.

The Inequality Profile (2021):

Absolute Drivers: IHD, COPD, and Lung Cancer.
Relative Drivers: Drug use, Self-harm, and Diabetes.
Absolute gaps are narrowing (Men), but relative gaps are widening for all.

Methodological Approaches

Individual-level data is essential for accurate RRs and understanding complex relationships. Hybrid Approach: A robust bridge for using BoD metrics with linked data.

Challenges & Solutions

High cost, administrative lag, and strict GDPR. Probabilistic linkage (Name/DOB); leveraging existing cohort-level studies; SEP-aggregated data; and collaboration.

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Thank You

Questions & Discussion

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